SECTION III
RESULTS AND DISCUSSION

A. FINFISH COMMUNITY

The finfish community in the C.P. Crane plant vicinity was sampled by trawling and beach seining during summer 1979 (July-August), winter 1979-80 (January), and spring 1980 (April-May), the periods of maximum and minimum water temperatures and spring spawning in the study area. Because of plant cycling operations, all samples were collected during the day or early evening.

The following subsections present seasonal catch data for all gear types, results of zooplankton sampling, and analysis of parasites on key species collected during seasonal surveys. Results of movement/spawning studies and age and growth analyses appear in subsections III.C and III.D; documentation of thermal regime/*in situ* measurements is in subsection III.E. Ecosystem effects are discussed in Section IV. Daily catch records, length frequency distribution/length weight and condition factor (K) analyses and daily thermal regime/*in situ* measurement data are in appendixes A and B.

1. Catch Composition and Spatial Distribution

a. Summer 1979

A total of 12,239 fish representing 26 species were collected during the summer sampling period using the two sampling techniques (tables 3-1 and 3-2). Trawling captured fewer species (23 seine, 17 trawl) but greater numbers of fish than did seining (9,750 trawl, 2,489 seine). Spot (74.7 percent), white perch (15.3 percent), and bay anchovy (4.7 percent) comprised approximately 95 percent of the total summer trawl catch. The seine catch was more evenly distributed among species, with tidewater silverside (26.2 percent), bay anchovy (17.6 percent), Atlantic menhaden (8.7 percent), white perch (8.1 percent), and spottail shiner (7.9 percent) accounting for 69 percent of the total seine catch.

Table 3-1

Mean Catch per Unit Effort (CPUE) and Total Catch of Fish Collected by Trawl in the C.P. Crane Study Area, Summer Season 1979

	Low Tide			High Tide			Site Summary		
Species	CPUE	Total Numbers	%	CPUE	Total Numbers	%	$\bar{X}$ CPUE	Total Numbers	%
American eel	0.9	37	0.7	0.6	25	0.6	0.7	62	0.6
Atlantic menhaden	<0.1	1	<0.1	0.1	3	0.1	<0.1	4	<0.1
Bay anchovy	6.6	277	5.1	4.3	180	4.2	5.4	457	4.7
Black bullhead	<0.1	1	<0.1				<0.1	1	<0.1
Bluegill				<0.1	2	<0.1	<0.1	2	<0.1
Brown bullhead	0.4	17	0.3	0.4	18	0.4	0.4	35	0.4
Channel catfish	0.6	27	0.5	0.7	28	0.7	0.7	55	0.6
Hogchoker	1.6	69	1.2	1.8	74	1.8	1.7	143	1.5
Largemouth bass	<0.1	1	<0.1				<0.1	1	<0.1
Pumpkinseed	<0.1	2	<0.1	<0.1	1	<0.1	<0.1	3	<0.1
Spot	99.7	4189	77.1	73.8	3099	71.3	86.8	7288	74.7
Spottail shiner	0.3	12	0.2	0.1	6	0.1	0.2	18	0.2
Striped bass	<0.1	1	<0.1	<0.1	1	<0.1	<0.1	2	<0.1
Tessellated darter	1.9	80	1.5	2.2	93	2.1	2.1	173	1.8
Tidewater silverside	0.1	4	0.1	0.2	8	0.2	0.1	12	0.1
White perch	16.9	709	13.1	18.5	778	18.0	17.7	1487	15.3
Yellow perch	0.1	4	0.1	0.1	3	0.1	0.1	7	0.1
Total mean CPUE	129.3			102.8			116.1		
Total numbers		5431			4319			9750	
Total number of species	16			15			17		

Table 3-2

Mean Catch per Unit Effort (CPUE) and Total Catch of Fish Collected by Beach Seine in the C.P. Crane Study Area, Summer Season 1979

	Low Tide			High Tide			Site Summary		
Species	CPUE	Total Numbers	%	CPUE	Total Numbers	%	$\bar{X}$ CPUE	Total Numbers	%
Alewife	<0.1	2	<0.1				<0.1	2	<0.1
American eel	0.3	14	1.1	0.3	12	0.9	0.3	26	1.0
Atlantic menhaden	2.3	96	8.6	2.9	121	8.9	2.6	217	8.7
Atlantic needlefish	<0.1	1	<0.1	0.1	6	0.3	0.1	7	0.3
Atlantic silverside				<0.1	1	<0.1	<0.1	1	<0.1
Banded killifish	3.1	130	11.5	1.4	57	4.3	2.2	187	7.5
Bay anchovy	3.3	137	12.3	7.1	300	21.9	5.2	437	17.6
Blueback herring	0.1	4	0.4	0.1	3	0.3	0.1	7	0.3
Bluegill	0.5	19	1.9	0.5	23	1.5	0.5	42	1.7
Carp				<0.1	1	<0.1	<0.1	1	<0.1
Channel catfish	0.1	4	0.4	<0.1	1	<0.1	0.1	5	0.2
Largemouth bass	0.4	16	1.5	0.3	12	0.9	0.3	28	1.1
Mummichog	0.3	11	1.1	0.2	10	0.6	0.2	21	0.8
Pumpkinseed	2.3	98	8.6	1.8	75	5.5	2.1	173	7.0
Rough silverside	0.7	31	2.6	3.1	131	9.6	1.9	162	6.5
Spot	0.9	39	3.3	0.4	15	1.2	0.6	54	2.2
Spottail shiner	2.0	82	7.4	2.7	115	8.3	2.3	197	7.9
Striped bass	0.1	4	0.4	0.1	4	0.3	0.1	8	0.3
Tessellated darter	0.5	19	1.9	0.2	8	0.6	0.3	27	1.1
Tidewater silverside	7.5	316	27.9	8.0	335	24.7	7.7	651	26.2
White crappie				<0.1	1	<0.1	<0.1	1	<0.1
White perch	2.0	86	7.4	2.8	116	8.6	2.4	202	8.1
Yellow perch	0.5	21	1.9	0.3	12	0.9	0.4	33	1.3
Total mean CPUE	26.9			32.4			29.6		
Total numbers		1130			1359			2489	
Total number of species	20			22			23		

Trawl

Trawling was effective in capturing demersal species in the relatively shallow study area, as evidenced by the catch composition (7,288 spot for 74.6 percent and 1,487 white perch for 15.3 percent) for this gear. Species taken in low numbers (<0.1 percent of total mean catch) included Atlantic menhaden, black bullhead, bluegill, largemouth bass, pumpkinseed, and striped bass.

Catch comparisons between tide stages revealed somewhat higher catches on low tide (5,431 individuals, 16 species) than on high tide (4,319 individuals, 15 species) (Table 3-1). The difference in total catch was due to the greater numbers of spot captured on low tide. Catches at the always-heated Saltpeter Creek discharge station were greater during high tide on five of seven sampling excursions, whereas numbers collected at the sometimes heated (heated on low tide) station at Saltpeter Creek mouth were greater on six of seven occasions on low tide. Overall catch per unit effort for the never-affected station off Battery Point, Gunpowder River was greater on low tide than high tide (Table 3-3 and appendix tables A-1 through A-3).

Catches at the always-heated station (Saltpeter Creek discharge) rose from 27 July to peak values on 2 August due primarily to increased catches of white perch (appendix Table A-1). Catches then declined on 6 August but remained stable through the remainder of the sampling period. Highest CPUE values observed at Saltpeter Creek mouth (sometimes affected) and Battery Point (never affected) occurred on 27 July, 16 August and 2 August, 13 August respectively (appendix tables A-1 through A-3).

The August 6 trawl catch at Buoy "R6" off Wier Point was primarily spot (224 individuals, 78.6 percent), American eel (32 specimens, 11.2 percent), and hogchoker (20 specimens, 7 percent). Species contributing 1 percent or less each to total catch were bay anchovy, channel catfish, striped bass, white catfish, and white perch. Slightly more fish were collected on high tide (148 individuals) than on low tide (137 individuals) (Table 3-4).

Table 3-3

Total Mean Catch per Unit Effort (CPUE)* for Fishes Collected by Trawl at Stations in the Vicinity of C.P. Crane Generating Station, Summer Season 1979

Species	Station 03 (Discharge) CPUE Low	%	High	%	Mean Catch** Tides Combined	%	Station 04 (Saltpeter Creek Mouth) CPUE Low	%	High	%	Mean Catch Tides Combined	%	Station 05 (Battery Point) CPUE Low	%	High	%	Mean Catch Tides Combined	%
American eel	0.3	0.4	0.3	0.3	0.3	0.3	0.9	0.5	0.8	0.9	0.9	0.7	1.4	1.0	0.7	0.6	1.0	0.8
Atlantic menhaden							0.1	0.1			0.05	0.1			0.2	0.2	0.1	0.1
Bay anchovy	2.1	2.7	2.8	2.8	0.3	0.3	9.5	5.6	1.1	1.2	5.3	4.0	8.2	5.8	9.0	7.8	8.6	6.7
Black bullhead							0.1	0.1			0.05	0.1						
Bluegill			0.1	0.1	0.05	0.1												
Brown bullhead	0.1	0.1			0.05	0.1							1.1	0.8	1.3	1.1	1.2	0.9
Channel catfish	0.5	0.7	0.4	0.4	0.5	0.6	0.4	0.2	0.4	0.4	0.4	0.3	1.0	0.7	1.2	1.0	1.1	0.9
Hogchoker	0.6	0.8	1.1	1.1	0.8	0.9	1.5	0.9	0.8	0.9	1.2	0.9	2.9	2.1	3.4	2.9	3.2	2.5
Largemouth bass	0.1	0.1			0.05	0.1												
Pumpkinseed	0.1	0.1	0.1	0.1	0.1	0.1							0.1	0.1			0.05	0.1
Spot	27.2	35.4	38.9	39.3	33.1	38.5	153.1	89.6	88.1	94.3	120.6	91.2	118.9	84.8	94.4	81.3	106.7	83.2
Spottail shiner	0.6	0.8	0.3	0.3	0.5	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Striped bass			0.1	0.1	0.05	0.1	0.1	0.1			0.05	0.1						
Tessellated darter	2.4	3.1	2.8	2.8	2.6	3.0	1.4	0.8	0.6	0.6	1.0	0.8	1.9	1.4	3.2	2.8	2.6	2.0
Tidewater silverside	0.1	0.1	0.5	0.5	0.3	0.3	0.2	0.1	0.1	0.1	0.2	0.2						
White perch	42.8	55.7	51.6	52.1	47.2	54.9	3.2	1.9	1.4	1.5	2.3	1.7	4.6	3.3	2.6	2.2	3.6	2.8
Yellow perch	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1			0.05	0.1			0.1	0.1	0.05	0.1
Total mean catch	76.8		99.0		86.0		170.9		93.4		132.2		140.3		116.1		128.3	
Total No. species	13		13		15		13		9		13		10		11		12	

*Mean CPUE represents mean CPUE of 7 nonconsecutive days of duplicate samples collected at each station on low and high tides.

**Mean catch (tides combined) represents the mean of mean CPUEs summed across tides at each station.

Table 3-4

Catch per Unit Effort for Fishes Collected by Trawl at Buoy "R6" off Wier Point, Gunpowder River, in the Vicinity of C.P. Crane Generating Station, 1979-1980

Season	Species	Low Tide	High Tide	Total Catch	Relative Abundance (%)
Summer	American eel	27	5	32	11.2
	Bay anchovy	3		3	1.0
	Channel catfish		1	1	0.4
	Hogchoker	9	11	20	7.0
	Spot	93	131	224	78.6
	Striped bass	1		1	0.4
	White catfish	1		1	0.4
	White perch	3		3	1.0
	Total No. Individuals	137	148	285	
	Total No. Species	7	4	8	
Winter	Spottail shiner	1		1	100.0
	Total No. Individuals	1			
	Total No. Species	1			
Spring	Americal eel	17	8	25	21.6
	Channel catfish	1		1	0.9
	Hogchoker		1	1	1.7
	White perch	11	74	85	73.3
	Yellow perch	2	1	3	2.6
	Total No. Individuals	31	85	116	
	Total No. Species	4	4	5	

Overall, the greatest number of species was collected in the Saltpeter Creek thermal discharge zone (always-affected), while the lowest number was recorded at Battery Point (never-affected). However, catches in the always-affected zone contained the lowest densities of the three areas sampled during the summer period. Catches in the always-affected area (Saltpeter Creek thermal discharge) were dominated by white perch (54.9 percent) and spot (38.5 percent). However, at Saltpeter Creek mouth (sometimes-affected and Battery Point (never-affected), white perch catches declined to less than 3 percent of the total CPUE; spot contribution rose to 91 percent and 83.2 percent respectively at these two stations. These data were subjected to statistical analyses to determine the significance of these apparent area differences.

Trawl catches were only sufficient to analyze catch-effort data for total densities, white perch, spot, and channel catfish. Densities (CPUE) were transformed by $\log_e$ (density + 1) to stabilize the variances for the analysis of variance (AOV). Results of these analyses of variance are summarized in Table 3-5. The only tests that showed significance at the $\alpha = 0.05$ level were the area tests for white perch and spot.

Table 3-5

Analysis of Variance Results for Trawl Catch Effort, Summer Season 1979

Source of Variation	Degrees of Freedom	White Perch Sum of Squares	White Perch Pr > F	Spot Sum of Squares	Spot Pr > F	Channel Cat Sum of Squares	Channel Cat Pr > F	Total Fish Sum of Squares	Total Fish Pr > F
Day	6	21.88		2.84		1.75		4.80	
Area	2	109.70	0.001	24.44	0.006	2.10	0.104	1.44	0.506
Day x area	12	17.22		18.16		4.58		12.00	
Tide	1	0.19	0.752	0.20	0.525	0.08	0.572	0.31	0.409
Day x tide	6	10.62		2.63		1.35		2.34	
Area x tide	2	1.60	0.139	1.91	0.224	0.02	0.979	2.22	0.116
Day x area x tide	12	4.11		6.74		4.88		5.14	
Residual	42	21.09		7.66		5.95		6.71	
Corrected total	83	186.42		64.58		20.70		34.96	

Area means are examined by Duncan's multiple range test at the $\alpha = 0.05$ level; results appear in Table 3-6. White perch densities did not differ statistically at the never-affected (Battery Point) and sometimes-affected (Saltpeter Creek mouth) areas; however, white perch catches were significantly larger ($\alpha = 0.05$) at the always-affected area (Saltpeter Creek thermal discharge) than at the other two areas. Conversely, spot densities did not differ significantly ($\alpha = 0.05$) at the never- and sometimes-affected areas but were significantly smaller ($\alpha = 0.05$) at the always-affected areas than at the other two locations.

A consequence of this reversal of always- and never-affected area means with the sometimes-affected area mean for white perch and spot was that these area differences became "averaged out" for total catch densities. Thus, no significant area differences were observed for total catch.

Table 3-6

Duncan's Multiple Range Test at $\alpha = 0.05$ for White Perch and Spot Area CPUE Means, Summer Season 1979

Species	Grouping*		Mean	N	Area
White perch	A		3.40	28	Always affected
		B	1.17	28	Never affected
		B	0.83	28	Sometimes affected
Spot	A		4.50	28	Never affected
	A		4.47	28	Sometimes affected
		B	3.34	28	Always affected

*Means with the same letter are not significantly different.

Although statistical analyses did not corroborate the initial implication of significantly lower total catches in the immediate vicinity of the thermal discharge, results of AOVs indicated an apparent thermal exclusion of spot and an attraction of white perch to the thermal discharge zone during summer 1979.

Seine

Seines captured primarily shore-zone, schooling species not effectively sampled by trawl. Overall, the shore-zone catch was dominated by common estuarine dependent species: tidewater silverside, bay anchovy, Atlantic menhaden, banded killifish, and white perch. Typically low-salinity-tolerant freshwater species (spottail shiner and pumpkinseed) contributed greater than 5 percent to the total seine catch (Table 3-2).

Slightly larger catches and greater numbers of species (1,359 individuals, 22 species) were taken on high tide than on low tide (1,130 individuals, 20 species) during the study period. Examination of catches at discharge and creek mouth stations revealed a pattern identical to that observed for trawl catches, i.e., greater numbers of specimens taken on high and low tide respectively. However, seine catches at Battery Point were slightly higher on high tide than low tide, a reversal of the pattern seen for trawls (Table 3-7).

Table 3-7

Total Mean Catch per Unit Effort (CPUE)* for Fishes Collected by Beach Seine at Stations in the Vicinity of C.P. Crane Generating Station, Summer Season 1979

	Station 03 (Discharge)						Station 04 (Saltpeter Creek Mouth)						Station 05 (Battery Point)					
	CPUE				Mean Catch**		CPUE				Mean Catch		CPUE				Mean Catch	
Species	Low	%	High	%	Tides Combined	%	Low	%	High	%	Tides Combined	%	Low	%	High	%	Tides Combined	%
Alewife													0.1	0.3			0.05	0.1
American eel	0.1	0.6	0.1	0.2	0.1	0.3	0.1	0.4	0.4	3.2	0.3	1.6	0.9	2.3	0.4	1.0	0.7	1.7
Atlantic menhaden			0.6	1.4	0.3	1.0							6.9	17.9	8.0	19.2	7.5	18.7
Atlantic needlefish			0.2	0.5	0.1	0.3	0.1	0.4	0.1	0.8	0.1	0.5			0.1	0.2	0.05	0.1
Atlantic silverside			0.1	0.2	0.05	0.2												
Banded killifish	5.7	33.7	3.2	7.4	4.5	15.0	3.5	13.8	0.9	7.3	2.2	11.6	0.1	0.3			0.05	0.1
Bay anchovy	3.1	18.3	11.3	26.3	7.2	29.0			0.1	0.8	0.05	0.3	6.7	17.4	10.0	24.0	8.4	20.9
Blueback herring													0.3	0.8	0.2	0.5	0.3	0.7
Bluegill			0.1	0.2	0.05	0.2	1.4	5.5	1.5	12.1	1.5	7.9						
Carp															0.1	0.2	0.05	0.1
Channel catfish													0.3	0.8	0.1	0.2	0.2	0.5
Largemouth bass	0.2	1.2	0.5	1.2	0.4	1.3	0.9	3.5	0.3	2.4	0.6	3.2			0.1	0.2	0.05	0.1
Mummichog	0.6	3.6	0.6	1.4	0.6	2.0	0.1	0.4	0.1	0.8	0.1	0.5						
Pumpkinseed	0.9	5.3	0.8	1.9	0.8	2.6	5.9	23.2	4.4	35.5	5.2	27.5	0.2	0.5	0.1	0.2	0.2	0.5
Rough silverside	0.1	0.6			0.0	0.0	0.1	0.4	0.1	0.8	0.1	0.5	2.1	5.5	9.3	22.3	5.7	14.2
Spot	0.9	5.3	0.6	1.4	0.8	2.6	0.4	1.6	0.2	1.6	0.3	1.6	1.6	4.2	0.2	0.5	0.9	2.2
Spottail shiner	1.2	7.1	4.4	10.2	2.8	9.3	1.6	6.3	0.4	3.2	1.0	5.3	3.0	7.8	3.5	8.4	3.3	8.2
Striped bass	0.1	0.6	0.1	0.2	0.1	0.3							0.2	0.5	0.2	0.5	0.2	0.5
Tessellated darter	0.1	0.6	0.1	0.2	0.1	0.3	1.0	3.9	0.4	3.2	0.7	3.7	0.3	0.8	0.1	0.2	0.2	0.5
Tidewater silverside	2.5	14.8	16.4	38.1	9.5	31.6	9.0	35.4	1.9	15.3	5.5	29.1	11.1	28.8	5.7	13.7	8.4	20.9
White crappie									0.1	0.8	0.05	0.3						
White perch	1.2	7.1	3.8	8.8	2.5	8.3	0.7	2.8	0.8	6.5	0.8	4.2	4.2	10.9	3.7	8.9	4.0	10.0
Yellow perch	0.2	1.2	0.1	0.2	0.2	0.7	0.6	2.4	0.7	5.6	0.7	3.7	0.6	1.6			0.3	0.7
Total Mean Catch	16.9		43.0		30.0		25.4		12.4		18.9		38.5		41.7		40.1	
Total No. Species	14		17		18		14		16		16		16		16		19	

*Mean CPUE represents mean CPUE of 7 nonconsecutive days of duplicate samples collected at each station on low and high tides.

**Mean catch (tides combined) represents the mean of mean CPUEs summed across tides at each station.

Seine CPUE at the thermal discharge station fluctuated during the study period, reaching a peak ($\bar{x}$ = 135) on 21 August, while catches at Saltpeter Creek mouth displayed no clear trends. CPUE at Battery Point station increased steadily from 4 August to peak values ($\bar{x}$ = 170) on 14 August and declined thereafter (appendix tables A-4 through A-6).

Greatest numbers of species and highest overall catches were collected at Battery Point (never-affected); lowest species numbers and total catches occurred at Saltpeter Creek mouth (Table 3-7). Tidewater silverside and bay anchovy were commonly encountered at all three sampling areas. Species encountered in abundance (>10 percent) at only one or two areas were banded killifish (discharge and creek mouth), pumpkinseed (creek mouth), and Atlantic menhaden, rough silverside, and white perch (Battery Point).

As with trawl data, densities (CPUE) were transformed by $\log_e$ (density + 1) for the analysis of variance. Results of these analyses are summarized in tables 3-8 and 3-9. Testing indicated significant differences (α = 0.05) of area mean densities for white perch, spottail shiner, Atlantic menhaden, and pumpkinseed, and at α = 0.06 for bay anchovy, and area-by-tide interaction for total fish and tidewater silverside. The tide test for white perch was almost significant (α = 0.07), suggesting that more white perch were collected by seine on high tide than on low tide.

Table 3-8

Analysis of Variance Results for Beach Seine Catch Effort, Summer Season 1979

		White Perch		Spot		Pumpkinseed		Total Fish	
Source of Variation	Degrees of Freedom	Sum of Squares	Pr > F	Sum of Squares	Pr > F	Sum of Squares	Pr > F	Sum of Squares	Pr > F
Day	6	4.17		4.17		4.97		1.14	
Area	2	16.80	0.004	0.87	0.337	23.34	0.001	5.50	0.154
Day x area	12	10.83		4.37		5.91		14.99	
Tide	1	0.84	0.073	0.87	0.279	0.54	0.120	0.42	0.368
Day x tide	6	1.07		3.69		0.99		2.63	
Area x tide	2	1.47	0.215	1.03	0.364	0.30	0.693	8.12	0.049
Day x area x tide	12	5.03		5.63		4.69		12.48	
Residual	42	15.08		5.49		12.40		12.91	
Corrected total	83	55.29		26.12		58.14		58.19	

Table 3-9

Analysis of Variance Results for Beach Seine Catch Effort, Summer Season 1979

		Bay Anchovy		Tidewater Silverside		Spottail Shiner		Atlantic Menhaden	
Source of Variation	Degrees of Freedom	Sum of Squares	Pr > F	Sum of Squares	Pr > F	Sum of Squares	Pr > F	Sum of Squares	Pr > F
Day	6	19.35		11.91		4.63		9.21	
Area	2	23.66	0.059	1.22	0.628	10.84	0.050	16.07	0.007
Day x Area	12	39.29		15.14		16.74		12.29	
Tide	1	2.30	0.237	0.04	0.887	0.57	0.427	0.70	0.331
Day x Tide	6	7.99		11.06		4.68		3.75	
Area x Tide	2	0.61	0.833	20.80	0.010	2.12	0.279	0.36	0.625
Day x Area x Tide	12	19.63		18.06		8.94		4.44	
Residual	42	9.47		29.32		14.11		26.14	
Corrected Total	83	122.29		107.54		62.63		72.96	

Duncan's multiple range test was used to discriminate among the area means whose F-test results were significant. Results of these tests appear in tables 3-10 and 3-11. No statistically significant differences were found at the $\alpha = 0.05$ level between white perch densities at Saltpeter Creek mouth (sometimes-affected) and the immediate thermal discharge area. Mean white perch catches were significantly larger ($\alpha = 0.05$) at Battery Point than at either of the other two areas; however, the relatively small sample size (due to low catches) used in analysis rendered this finding of limited ecological significance. Catches of pumpkinseed were shown to be significantly larger ($\alpha = 0.05$) at Saltpeter Creek mouth (sometimes-affected) than at always- and never-affected areas; no differences were found between the latter two area means. Catches of bay anchovy and spottail shiner were significantly larger ($\alpha = 0.05$) at the Battery Point station (never-affected) than at the Saltpeter Creek mouth (sometimes-affected) station. Catches of Atlantic menhaden were significantly larger ($\alpha = 0.05$) at Battery Point than at Saltpeter Creek mouth or in the plant discharge vicinity. No statistically significant differences were detected for total catch among the three test areas.

Table 3-10

Duncan's Multiple Range Test at $\alpha = 0.05$ for White Perch and Pumpkinseed Area Means and for Total Fish Area-by-Tide Means, Summer Season 1979

Species	Grouping		Mean	N	Area	Tide
White perch	A		1.42	28	Never affected	
		B	0.84	28	Always affected	
		B	0.33	28	Sometimes affected	
Pumpkinseed	A		1.48	28	Sometimes affected	
		B	0.43	28	Always affected	
		B	0.12	28	Never affected	
Total fish	A		3.43	14	Never affected	Low
	A		3.42	14	Always affected	High
	A		3.29	14	Never affected	High
	A		3.19	14	Sometimes affected	Low
	A	B	2.30	14	Always affected	Low
		B	2.29	14	Sometimes affected	High

Table 3-11

Duncan's Multiple Range Test at $\alpha = 0.05$ for Bay Anchovy, Spottail Shiner, and Atlantic Menhaden Area Means and for Tidewater Silverside Area-by-Tide Means, Summer Season 1979

	Grouping		Mean	N	Area	Tide
Bay Anchovy	A		1.31	28	Never Affected	
	A	B	0.95	28	Always Affected	
		B	0.05	28	Sometimes Affected	
Spottail Shiner	A		1.21	28	Never Affected	
	A	B	0.80	28	Always Affected	
		B	0.33	28	Sometimes Affected	
Atlantic Menhaden	A		0.98	28	Never Affected	
		B	0.12	28	Always Affected	
		B	0.00	28	Sometimes Affected	
Tidewater Silverside	A		2.26	14	Always Affected	High
	A	B	1.88	14	Never Affected	Low
	A	B	1.82	14	Sometimes Affected	Low
	A	B	1.34	14	Never Affected	High
		B	0.92	14	Always Affected	Low
		B	0.87	14	Sometimes Affected	High

Area-by-tide means were examined using Duncan's multiple range test. Catches of tidewater silverside were significantly larger ($\alpha = 0.05$) at the plant discharge station at high tide than at low tide and at Saltpeter Creek mouth at high tide. Total seine catches at high tide were significantly lower at Saltpeter Creek mouth that at all other area-by-tide combinations except for the immediate discharge area at low tide. A partial explanation for significantly lower catches in the creek mouth test area may be a loss in gear and sampling efficiency precipitated by inundation of this heavily vegetated shoreline (Nichols, et al. 1980) during high tide. Low catches in the immediate area of the thermal discharge on low tide (the period of potentially maximum water temperatures in this zone) may indicate thermal exclusion or habitat preference by shore-zone species.

b. Winter 1979-1980

Sampling during the winter season (January 1980) was curtailed from the originally scheduled 7 nonconsecutive days to 5 non-consecutive days because of ice conditions in the study area. Overall, catches declined substantially during winter, when only 369 fish representing 23 species were collected in the study area by trawl and seine (tables 3-12 and 3-13). Unlike summer, winter trawling captured more species and individuals than did seining (trawl: 21 species and 313 individuals, seine: nine species and 56 individuals), suggesting abandonment of shallow, colder, shore-zone waters for deeper and potentially warmer areas. Resident species, spottail shiner (26.2 percent), yellow perch (20.8 percent), pumpkinseed (10.4 percent), and gizzard shad (8.9 percent), and the seasonal migrant Atlantic croaker (7.6 percent) made up 73.9 percent of the total winter trawl catch (Table 3-12). The remaining 16 species each contributed less than 6 percent to the total catch. Winter seine collections were dominated by resident banded killifish (25 percent), tidewater silverside (25 percent), spottail shiner (16.8 percent), and gizzard shad (12.1 percent), accounting for 78.9 percent of the winter seine catch.

<u>Trawl</u>

The trawl catch during winter was almost entirely resident bay species (95 percent). The marine migrant Atlantic croaker contributed 24 individuals (7.6 percent during January; this species was also taken in low numbers by Ecological Analysts, Inc. (EA) (1980) during October through November 1979 in the study area.

Table 3-12

Mean Catch per Unit Effort (CPUE) and Total Catch of Fish Collected by Trawl in the C.P. Crane Study Area, Winter Season 1980

Species	Low Tide CPUE	Low Tide Total Numbers	Low Tide %	High Tide CPUE	High Tide Total Numbers	High Tide %	Site Summary CPUE	Site Summary Total Numbers	Site Summary %
American eel	0.0	1	0.6	0.0	1	0.7	0.0	2	0.6
Atlantic croaker	0.3	9	5.0	0.5	15	10.9	0.4	24	7.6
Bay anchovy	0.0	1	0.7	0.1	3	2.2	0.1	4	1.3
Bluegill	0.0	1	0.6	0.1	2	1.4	0.0	3	0.9
Brown bullhead				0.0	1	0.7	0.0	1	0.3
Carp	0.3	10	5.6	0.2	7	5.1	0.3	17	5.4
Channel catfish	0.1	2	1.1	0.0	1	0.7	0.0	3	0.9
Emerald shiner	0.0	1	0.6				0.0	1	0.3
Gizzard shad	0.5	14	8.0	0.5	14	10.1	0.5	28	8.9
Golden shiner				0.0	1	0.7	0.0	1	0.3
Hogchoker	0.1	2	1.3				0.0	2	0.7
Largemouth bass				0.0	1	0.7	0.0	1	0.3
Pumpkinseed	0.5	14	7.8	0.6	19	13.8	0.5	33	10.4
Rough silverside				0.1	2	1.4	0.0	2	0.6
Silvery minnow	0.0	1	0.6				0.0	1	0.3
Spottail shiner	2.1	62	35.2	0.7	20	14.5	1.4	82	26.2
Sunfish (unident.)	0.1	3	1.7	0.0	1	0.7	0.1	4	1.3
Tessellated darter	0.3	8	4.6	0.3	10	7.2	0.3	18	5.8
Tidewater silverside				0.1	3	2.2	0.0	3	0.9
White perch	0.4	12	7.1	0.2	6	4.3	0.3	18	5.9
Yellow perch	1.2	34	19.6	1.0	31	22.5	1.1	65	20.8
Total mean CPUE	6.0			4.6			5.3		
Total numbers		175			138			313	
Total No. of species			16			18			21

Table 3-13

Mean Catch per Unit Effort (CPUE) and Total Catch of Fish Collected by Beach Seine in the C.P. Crane Study Area, Winter Season, 1980

Species	Low Tide CPUE	Low Tide Total Numbers	Low Tide %	High Tide CPUE	High Tide Total Numbers	High Tide %	Site Summary $\bar{x}$ CPUE	Site Summary Total Numbers	Site Summary %
Banded killifish	0.2	6	28.6	0.3	8	22.9	0.2	14	25.0
Bluegill				<0.1	1	2.9	<0.1	1	1.7
Emerald shiner				0.1	2	5.7	<0.1	2	3.4
Gizzard shad	0.1	2	9.5	0.2	5	14.3	0.1	7	12.1
Mummichog	0.1	2	9.5	0.1	2	5.7	0.1	4	7.3
Silvery minnow				0.1	2	5.7	<0.1	2	3.4
Spottail shiner	0.1	3	14.3	0.2	6	17.1	0.2	9	16.8
Tidewater silverside	0.3	8	38.1	0.2	6	17.1	0.2	14	25.0
Yellow perch				0.1	3	8.6	<0.1	3	5.2
Total mean CPUE	0.8			1.2			1.0		
Total numbers		21			35			56	
Total No. of species	5			9			9		

Catch comparisons between tide stages showed slightly higher catches but fewer species on low tide (175 individuals, 16 species) than on high tide (138 individuals, 18 species) (Table 3-12). The difference in total catch during January 1980 was due to greater numbers of spottail shiner taken on low tide in the vicinity of the thermal discharge (station 03).

Catches at always-heated Saltpeter Creek discharge station were greater on low tide than on high tide, due primarily to a single large catch of spottail shiner on 28 January (appendix Table A-7). Catches at Saltpeter Creek mouth and Battery Point were approximately the same on both tides (Table 3-14 and appendix Table A-7). Numbers of individuals and numbers of species generally increased at always thermally affected station 03 (Saltpeter Creek discharge) over the 5 nonconsecutive days sampled, until ice conditions at never-affected and sometimes-affected stations 05 and 04 made further sampling impossible. Catches at stations 04 and 05 were sporadic, and no consistent trends were discerned (appendix Table A-7). Trawling at Buoy "R6" off Wier Point during January 1980 produced only a single spottail shiner, taken on low tide (Table 3-4).

Trawling for the winter season was suspended for the last two regularly scheduled sampling days due to ice conditions at the sometimes- and never-affected stations 04 and 05. Catches were sufficient to support analysis for the following species/catch categories: 1) yellow perch density, 2) pumpkinseed dentsity, 3) gizzard shad density, 4) total density. The densities (CPUE) were transformed by $\log_e$ (density + 1) for the analysis of variance. The results of these anslyses of variance are summarized in Table 3-15.

The loss of two sampling days from the finfish model for the winter season adjusted the a priori power estimate to 0.50 at $\alpha = 0.05$. Examination of the winter data showed that the six sample coefficients of variation (area-by-tide) were between 0.28 and 0.98. Accordingly, the power was estimated to be 0.92 for detecting a difference equal to 50 percent of the maximum mean. This increase in power over the original a priori estimate of 0.80 is explained by the coefficient of variation of the maximum mean (0.286) being much smaller than 0.50. The power for detecting a difference equal to 50 percent of the

Table 3-14

Total Mean Catch per Unit Effort (CPUE)* for Fishes Collected by Trawl at Stations in Vicinity of C.P. Crane Generating Station, Winter 1980

	Station 03 (Discharge)						Station 04 (Saltpeter Creek Mouth)						Station 05 (Battery Point)					
	CPUE				Mean Catch**		CPUE				Mean Catch		CPUE				Mean Catch	
Species	Low	%	High	%	Tides Combined	%	Low	%	High	%	Tides Combined	%	Low	%	High	%	Tides Combined	%
American eel			0.10	1.3	0.05	0.5							0.10	2.6			0.05	1.3
Atlantic croaker	0.40	3.3	1.20	15.6	0.80	8.1							0.50	12.8	0.30	7.5	0.40	10.0
Bay anchovy							0.10	6.7	0.20	9.5	0.20	9.5			0.10	2.5	0.05	1.3
Bluegill	0.10	0.8	0.20	2.6	0.20	2.0												
Brown bullhead															0.10	2.5	0.05	1.3
Carp	1.00	8.3	0.50	6.5	0.80	8.1									0.20	5.0	0.10	2.5
Channel catfish													0.20	5.1	0.10	2.5	0.20	5.0
Emerald shiner	0.10	0.8			0.05	0.5												
Gizzard shad	1.00	8.3	0.80	10.4	0.90	9.1	0.10	6.7	0.50	23.8	0.80	14.3	0.30	7.7	0.10	2.5	0.20	5.0
Golden shiner			0.10	1.3	0.05	0.5												
Hogchoker							0.10	6.7			0.05	2.3	0.10	2.6			0.05	1.3
Largemouth bass			0.10	1.3	0.05	0.5												
Pumpkinseed	0.70	5.8	0.60	7.8	0.70	7.1			0.10	4.8	0.05	2.3	0.70	17.9	1.20	30.0	1.00	25.0
Rough silverside			0.20	2.6	0.10	1.0												
Silvery minnow	0.10	0.8			0.05	0.5												
Spottail shiner	5.50	45.5	1.70	22.1	3.60	36.4	0.50	26.7			0.30	14.3	0.30	7.7	0.30	7.5	0.30	7.5
Sunfish (unident)	0.20	1.7			0.10	1.0							0.10	2.6	0.10	2.5	0.10	2.5
Tessellated darter	0.30	2.5	0.30	3.9	0.30	3.0	0.10	6.7	0.50	23.8	0.80	14.3	0.40	10.3	0.20	5.0	0.30	7.5
Tidewater silverside			0.20	2.6	0.10	1.0									0.10	2.5	0.05	1.3
White perch	0.80	6.6	0.50	6.5	0.70	7.1	0.40	20.0	0.10	4.8	0.30	14.3	0.10	2.6			0.05	1.3
Yellow perch	1.90	15.7	1.20	15.6	1.60	16.2	0.50	26.7	0.70	33.3	0.60	28.6	1.10	28.2	1.20	30.0	1.10	27.5
Total mean catch	12.10		7.70		9.90		1.90		2.10		2.10		3.90		4.00		4.00	
Total No. species	12		14		17		7		6		8		11		12		14	

*Mean CPUE represents mean CPUE of 5 nonconsecutive days of duplicate samples collected at each station on low and high tides.

**Mean catch (tides combined) represents the mean of mean CPUEs summed across tides at each station.

minimum mean was estimated to be 0.52. This value agrees with the revised *a priori* estimate because the sample coefficient of variation of the smallest mean (0.974) is at the assumed level of 1.00 for the model.

Table 3-15

Analysis of Variance Results for Winter 1980 Trawl Catch

Source of Variation	Degrees of Freedom	Yellow Perch Sum of Squares	Yellow Perch $P_r > F$	Pumpkinseed Sum of Squares	Pumpkinseed $P_r > F$	Gizzard Shad Sum of Squares	Gizzard Shad $P_r > F$	Total Density Sum of Squares	Total Density $P_r > F$
Day	4	1.54		0.66		0.82		6.22	
Area	2	0.90	0.54	2.00	0.18	1.32	0.32	7.71	0.36
Day x Area	8	5.50	0.13	3.72	0.06	4.03	0.05	26.13	<0.01
Tide	1	0.02	0.89	0.03	0.66	0.03	0.66	0.51	0.44
Day x Tide	4	2.83		0.57		0.54		2.77	
Area x Tide	2	0.38	0.53	0.08	0.77	0.32	0.42	3.08	0.05
Day x Area x Tide	8	2.23	0.46	1.30	0.57	1.31	0.38	2.63	0.38
Residual	30	8.35		5.75		4.40		8.81	
Corrected Total	59	21.76		14.12		12.78		57.86	

The hypothesis of equal area means was not rejected at the $\alpha = 0.05$ or $\alpha = 0.10$ level of significance for any species/total catch category tested. In fact, the lowest p-value in the F test for differences in area means was only 0.18.

There was a significant difference in the changes in means of the area-by-tide interaction for total density with $\alpha = 0.05$. Because the effect of this interaction was not significant for any of the most abundant species, the result of significance was considered a cumulative effect of the tendencies of all species. At low tide in the always- and never-affected areas, there were proportional increases in mean CPUE over those obtained at high tide. However, in the sometimes-affected area there was a marked decrease (approximately 50 percent) in the mean CPUE at low tide over that obtained at high tide. This phenomenon can be seen in the area-by-tide interaction plot in Figure 3-1.

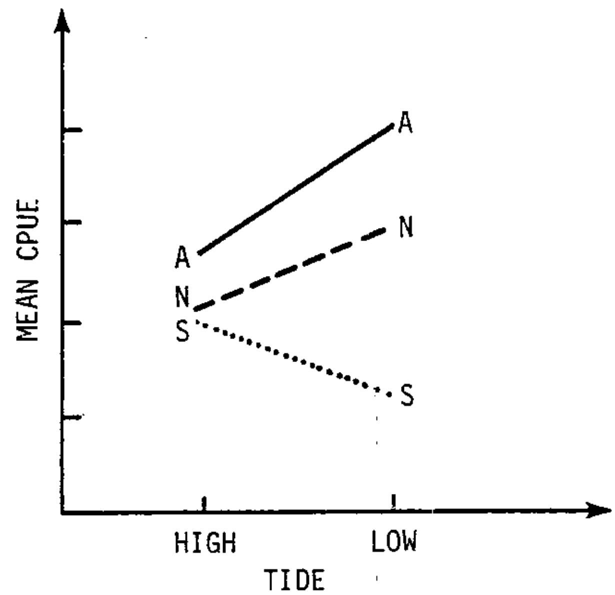

Figure 3-1. Area-by-Tide Interaction Plot for Total Density of Fish Collected by Trawl during Winter Sampling 1980

The most significant term in the model was the day-by-area interaction, plotted in Figure 3-2 for total fish density. The plot shows that for days 4 and 5, significant increases in mean CPUE were obtained in the always-affected area (Saltpeter Creek discharge station 03). Mean CPUE for the other areas by day was significantly smaller than the mean CPUE for days 4 and 5 in the always-affected area. An examination of in-situ water temperature data for this time period revealed that days 4 and 5 were decidedly colder than the previous sampling days (appendix Table B-2). In other words, the fish were especially attracted to the thermal effluent of C.P. Crane in extreme cold weather.

Each of the most abundant species was attracted to the thermal effluent in extreme cold during the winter season (yellow perch, pumpkinseed, gizzard shad). This suggests that air temperature and fish densities in the thermal effluent were negatively correlated.

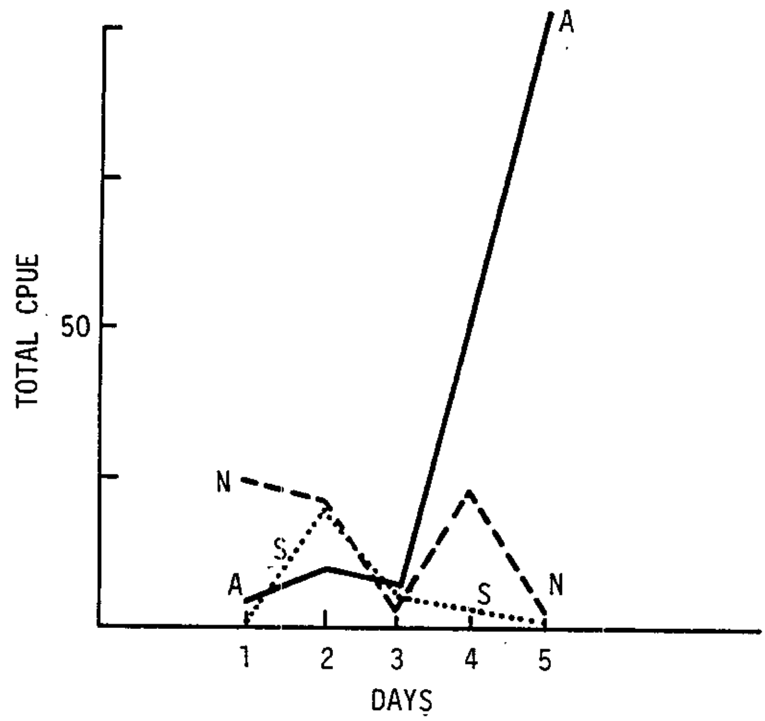

Figure 3-2. Day-by-Area Interaction Plot for Total Density of Fish Collected by Trawl, Winter Season 1980

Seine

Winter seining collected only resident bay species, and catches were dominated by schooling, inshore fishes not effectively sampled by trawl. The catch was dominated by estuarine-dependent tidewater silverside, low-salinity-tolerant freshwater species (banded killifish and spottail shiner), and juvenile gizzard shad (Table 3-16). Gizzard shad was collected throughout the winter months in the study area in both trawl and seine by EA (1980).

As noted for summer 1979 seine data, somewhat higher catches were taken on high tide (35 individuals, 9 species) than on low tide (21 individuals, 5 species). Station comparisons, also based on these low catches, revealed slightly higher numbers of individuals and species numbers at thermal discharge station 03 and sometimes thermally affected station 04 and a reversal of this finding at never thermally affected station 05 (Battery Point) (Table 3-16 and appendix Table A-8). Catches at all three stations were sporadic during the winter season, and no consistent abundance trends were discerned.

Table 3-16

Total Mean Catch per Unit Effort (CPUE)* for Fish Collected by Seine at Stations in Vicinity of C.P. Crane Generating Station, Winter 1980

	Station 03 (Discharge)						Station 04 (Saltpeter Creek Mouth)						Station 05 (Battery Point)					
	CPUE				Mean Catch**		CPUE				Mean Catch		CPUE				Mean Catch	
Species	Low	%	High	%	Tides Combined	%	Low	%	High	%	Tides Combined	%	Low	%	High	%	Tides Combined	%
Banded Killifish	0.10	16.7	0.80	61.5	0.45	45.0	0.30	25.0			0.15	10.0	0.30	42.9			0.15	30.0
Bluegill									0.10	5.3	0.05	3.3						
Emerald shiner															0.20	66.7	0.10	20.0
Gizzard shad									0.50	26.3	0.25	16.7	0.20	28.6			0.10	20.0
Mummichog	0.10	16.7	0.20	15.4	0.10	20.0	0.10	12.5			0.05	3.3						
Silvery minnow									0.20	10.5	0.10	6.7						
Spottail shiner			0.10	7.7	0.05	5.0	0.40	37.5	0.50	26.3	0.45	30.0						
Tidewater silverside	0.40	66.7	0.20	15.4	0.30	30.0	0.30	25.0	0.40	21.1	0.35	23.3	0.20	28.6			0.10	20.0
Yellow perch									0.20	10.5	0.10	6.7			0.10	33.3	0.05	10.0
Total mean catch	0.60		1.30		1.00		1.00		1.90		1.50		0.70		0.30		0.50	
Total No. species	3		4		4		4		6		8		3		2		5	

*Mean CPUE represents mean CPUE of 5 nonconsecutive days of duplicate samples collected at each station on low and high tides.

**Mean catch (tides combined) represents the mean of mean CPUEs summed across tides at each station.

Seining for the winter season was suspended for the last 2 days of the regularly scheduled sampling period because of ice conditions at the sometimes- and never-affected stations 04 and 05. Catches were suficient to support analysis of the following species/catch categories: 1) banded killifish, 2) tidewater silverside, 3) mummichog, 4) total density. Densities (CPUE) were transformed by $\log_e$ (density + 1) for the analysis of variance, and the results of these analyses of variance are summarized in Table 3-17.

Table 3-17

Analysis of Variance Results for Winter 1980 Seine Catch

Source of Variation	Degrees of Freedom	Banded Killifish		Tidewater Silverside		Mummichog		Total Density	
		Sum of Squares	$P_r > F$	Sum of Squares	$P_r > F$	Sum of Squares	$P_r > F$	Sum of Squares	$P_r > F$
Day	4	0.43		1.38		0.27		7.03	
Area	2	0.58	<0.01	0.21	0.28	0.11	0.18	0.92	0.48
Day x Area	8	0.18		0.55		0.21		4.53	
Tide	1	0.02	0.52	0.03	0.10	0.00	1.00	0.02	0.65
Day x Tide	4	0.16		0.03		0.08		0.29	
Area x Tide	2	1.17	0.06	0.18	0.53	0.05	0.24	1.59	0.08
Day x Area x Tide	8	1.14	0.14	1.08	0.14	0.11	0.89	1.86	0.23
Residual	30	2.49		2.37		0.96		4.91	
Corrected Total	59	6.16		5.83		1.79		21.15	

The hypothesis of equal area means was rejected at the $\alpha = 0.05$ level of significance for banded killifish only. The hypothesis of equal tide means was not rejected at the $\alpha = 0.05$ level of significance for any category. Duncan's multiple range test was used to discriminate among the area means for banded killifish, and results are given in Table 3-18. Test results indicated that the mean catches of banded killifish were significantly larger in the always-affected area than at either the never- or the sometimes-affected area, indicating an apparent attraction to the warmer waters in the vicinity of the thermal discharge. However, the extremely low catches of this and other species encountered during the winter season render this finding of little ecological significance.

Table 3-18

Duncan's Multiple Range Test at $\alpha = 0.05$ for Banded Killifish Area CPUE Means, Winter Season 1980

Grouping	Mean	N	Area
A	0.28	20	Always affected
B	0.10	20	Never affected
B	0.05	20	Sometimes affected

Additionally, a significant area-by-tide interaction term was observed for banded killifish and total density. The significance of this effect indicated that differences between area means were not consistent at high and low tides. The area-by-tide interaction plots are given in figures 3-3 and 3-4 for banded killifish and total density respectively. For banded killifish, mean catches were significantly less at low tides than at high tides. However, in the never-affected and sometimes-affected areas, mean catches were significantly higher at low tides than at high tides. For total density, mean catches in the never-affected area were significantly higher at low tides observed than at high tides. However, the opposite occurred for the always- and sometimes-affected areas. In these areas, mean CPUE was significantly lower at low tides than at high tides. However, the low seine catches render the statistical conclusions of only slight ecological significance.

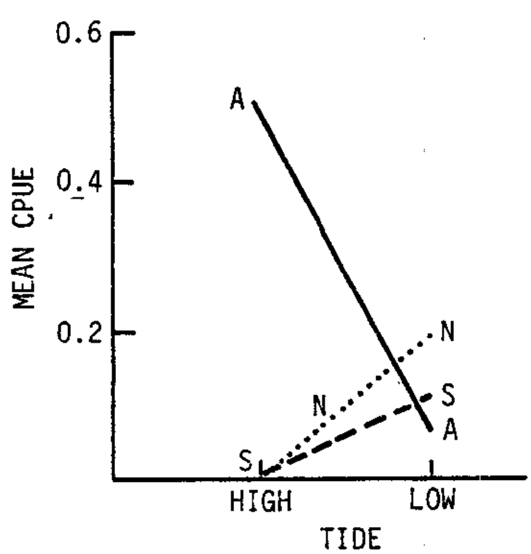

Figure 3-3. Area-by-Tide Interaction Plot for Mean CPUE of Banded Killifish Collected by Seine, Winter Season 1980

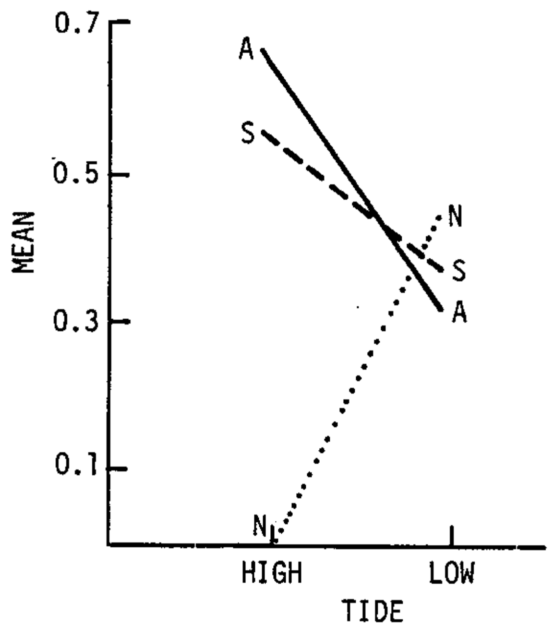

Figure 3-4. Area-by-Tide Interaction Plot for Total Density of Fish Collected by Seine, Winter Season 1980

c. Spring 1980

Trawl and seine sampling was conducted over 7 nonconsecutive days during April 1980 and collected a total of 3,575 individuals of 29 species (tables 3-19 and 3-20). Trawling collected more individuals than did seining (2,567 trawl, 1,008 seine) but fewer species (22 trawl, 24 seine). White perch (54.8 percent), yellow perch (14.3 percent) (both spring spawners), American eel (12.4 percent), pumpkinseed (9.6 percent), and spottail shiner (3.5 percent) contributed 95 percent of total numbers collected by trawl.

The remaining 17 species contributed only 5 percent to total catch. Seine catches were dominated by predominantly shore-zone schooling species, namely tidewater silverside (32 percent), blueback herring (19 percent), white perch (15.2 percent), banded killifish (5.4 percent), and Atlantic silverside (5.2 percent) (Table 3-20).

Table 3-19

Mean Catch per Unit Effort (CPUE) and Total Catch of Fish Collected by Trawl in the C.P. Crane Study Area, Spring Season 1980

Species	Low Tide			High Tide			Site Summary		
	CPUE	Total Numbers	%	CPUE	Total Numbers	%	x̄ CPUE	Total Numbers	%
Alewife	<0.10	1	0.1	<0.10	1	0.1	<0.10	2	0.1
American eel	5.60	237	15.4	1.90	81	7.8	3.80	318	12.4
Atlantic menhaden	0.30	13	0.8	0.30	14	1.4	0.30	27	1.1
Bay anchovy	0.20	7	0.5	0.10	5	0.5	0.10	12	0.5
Black bullhead	<0.10	1	0.1	NC			<0.10	1	<0.1
Bluegill	<0.10	1	0.1	0.10	4	0.4	0.10	5	0.2
Brown bullhead	0.20	8	0.5	0.20	7	0.7	0.20	15	0.6
Carp	<0.10	1	0.1	NC			<0.10	1	<0.1
Channel catfish	<0.10	2	0.1	0.10	6	0.6	0.10	8	0.3
Gizzard shad	0.10	4	0.3	<0.10	2	0.2	0.10	6	0.2
Green sunfish	NC			<0.10	1	0.1	<0.10	1	<0.1
Herring (unident.)	NC			<0.10	1	0.1	<0.10	1	<0.1
Hogchoker	0.60	27	1.8	0.20	8	0.8	0.40	35	1.4
Largemouth bass	<0.10	1	0.1	<0.10	1	0.1	<0.10	2	0.1
Pumpkinseed	3.5	145	9.5	2.40	101	9.8	2.90	246	9.6
Redbreast sunfish	NC			0.10	4	0.4	<0.10	4	0.2
Spottail shiner	1.00	40	2.6	1.20	49	4.7	1.10	89	3.5
Tessellated darter	0.30	12	0.8	0.10	3	0.3	0.20	15	0.6
Tidewater silverside	<0.10	1	0.1	NC			<0.10	1	<0.1
White catfish	<0.10	2	0.1	<0.10	1	0.1	<0.10	3	0.1
White perch	18.90	795	51.8	14.6	612	59.2	16.7	1407	54.8
Yellow perch	5.60	236	15.4	3.10	132	12.8	4.40	368	14.3
Total mean CPUE	36.5			24.6			30.6		
Total numbers		1534			1033			2567	
Total number of species	19			19			22		

Table 3-20

Mean Catch per Unit Effort (CPUE) and Total Catch of Fish Collected by Seine in the C.P. Crane Study Area, Spring Season 1980

Species	Low Tide			High Tide			Site Summary		
	CPUE	Total Numbers	%	CPUE	Total Numbers	%	x̄ CPUE	Total Numbers	%
Alewife	NC			<0.10	1	0.2	<0.10	1	0.1
American eel	0.20	7	1.5	0.20	10	1.8	0.20	17	1.7
Atlantic menhaden	0.10	5	1.1	0.60	25	4.6	0.40	30	3.0
Atlantic silverside	0.50	23	5.0	0.70	29	5.3	0.60	52	5.2
Banded killifish	1.00	42	9.1	0.30	12	2.2	0.60	54	5.4
Bay anchovy	<0.10	1	0.2	0.10	4	0.7	0.10	5	0.5
Blueback herring	0.10	4	0.9	4.50	188	34.4	2.3	192	19.0
Bluegill	0.10	3	0.6	<0.10	1	0.2	<0.10	4	0.4
Brown bullhead	NC			<0.10	1	0.2	<0.10	1	0.1
Carp	<0.10	1	0.2	<0.10	1	0.2	<0.10	2	0.2
Catfish (unident.)	NC			<0.10	2	0.4	<0.10	2	0.2
Gizzard shad	<0.10	1	0.2	0.20	7	1.3	0.10	8	0.8
Golden shiner	<0.10	1	0.2	NC			<0.10	1	0.1
Herring (unident.)	0.20	10	2.2	0.10	3	0.5	0.20	13	1.3
Largemouth bass	<0.10	1	0.2	0.10	3	0.5	<0.10	4	0.4
Mummichog	0.40	18	3.9	0.30	14	2.6	0.40	32	3.2
Pumpkinseed	0.20	10	2.2	0.10	5	0.9	0.20	15	1.5
Rainbow smelt	0.10	3	0.6	<0.10	2	0.4	0.10	5	0.5
Rough silverside	0.90	37	8.0	<0.10	1	0.2	0.50	38	3.8
Spottail shiner	0.60	26	5.6	0.30	14	2.6	0.50	40	4.0
Tessellated darter	0.10	6	1.3	NC			0.10	6	0.6
Tidewater silverside	4.0	167	36.1	3.7	156	28.6	3.8	323	32.0
White perch	2.20	91	19.7	1.5	62	11.4	1.8	153	15.2
Yellow perch	0.10	5	1.1	0.10	5	0.9	0.10	10	1.0
Total mean CPUE	11.0			13.0			12.0		
Total numbers		462			546			1008	
Total No. of species	21			22			24		

Trawl

Trawling was effective in collecting the demersal spring spawners white perch (1407 individuals) and yellow perch (368 individuals) as well as resident American eel (318 individuals) and pumpkinseed (246 individuals) (Table 3-19).

Overall, catch comparisons revealed greater catches on low tide (1,534 individuals, 19 species) than on high tide (1,033 individuals, 19 species), a trend observed for winter 1980 trawl catches as well (tables 3-12 and 3-19). Higher low-tide catches than high-tide catches were recorded at the never- and sometimes-affected stations sampled during April 1980; however, high- and low-tide catches at the thermal discharge station were approximately equal (Table 3-21 and appendix Table A-9).

Catches at always-heated station 03 (Saltpeter Creek discharge) were highest on the first sampling date (123 individuals), fluctuated on the next three sampling dates, and declined to lowest values recorded at this station during the spring period (26 individuals on the last sampling date). Catches at stations 04 and 05 fluctuated on a cyclic basis over the 7-nonconsecutive-day period (appendix Table A-9); the apparent cyclic nature of abundance patterns at those two stations as well as abundances at station 03 depended heavily on white perch catches and to lesser extent on yellow perch abundances, which fluctuated from day to day. These daily fluctuations may have been related to inshore movement to creek areas and subsequent spawning activities in the study area; sexual condition data indicated that the majority of white perch collected by trawl, seine, and gill net were in a "ripe and running" condition during the spring study period.

Spring trawl catches off Wier Point during April 1980 collected a total of 116 individuals representing five taxa. Catch composition comprised 85 white perch (73 percent), 25 American eel (22 percent), 3 yellow perch (3 percent), 1 hogchoker and 1 channel catfish. More fish were collected on high tide (85 individuals) than on low tide (31 individuals) due to a large catch of white perch (74 indivduals). American eel (17 individuals) and white perch (11 individuals) dominated the low-tide catch (Table 3-4).

Table 3-21

Total Mean Catch per Unit Effort (CPUE)* for Fishes Collected by Trawl at Stations in the Vicinity of C.P. Crane Generating Station, Spring Season 1980

Species	Station 03 (Discharge) CPUE Low	%	High	%	Mean Catch** Tides Combined	%	Station 04 (Saltpeter Creek Mouth) CPUE Low	%	High	%	Mean Catch Tides Combined	%	Station 05 (Battery Point) CPUE Low	%	High	%	Mean Catch Tides Combined	%
Alewife	NC		NC				NC		NC		NC		0.10	0.2	0.10	0.3	0.10	0.3
American eel	2.90	13.0	2.10	9.7	2.50	11.5	11.20	23.2	2.70	9.6	6.95	18.2	2.90	7.3	1.00	4.1	1.95	6.2
Atlantic menhaden	0.10	0.3	0.10	0.7	0.10	0.5	0.60	1.3	0.40	1.5	0.50	1.3	0.20	0.5	0.40	1.8	0.30	0.9
Bay anchovy	NC		0.10	0.7	0.05	0.2	0.20	0.4	0.10	0.5	0.15	0.4	0.30	0.7	0.10	0.3	0.20	0.6
Black bullhead	NC		NC		NC		0.10	0.1	NC		0.05	0.1	NC		NC		NC	
Bluegill	0.10	0.3	0.10		0.05	0.2	NC		0.30	1.0	0.15	0.4	NC		NC		NC	
Brown bullhead	NC		NC	0.7	0.05	0.2	0.40	0.9	0.40	1.3	0.40	1.1	0.10	0.4	NC		0.05	0.2
Carp	NC		0.30		NC		NC		NC		NC		0.10	0.2	NC		0.05	0.2
Channel catfish	0.10	0.6	0.10	1.3	0.20	0.9	NC		0.10	0.3	0.05	0.1	NC		0.10	0.3	0.05	0.2
Gizzard shad	0.10	0.6	NC	0.3	0.10	0.5	0.10	0.3	NC		0.05	0.1	NC		0.10	0.3	0.05	0.2
Green sunfish	NC		NC		NC		NC		0.10	0.3	0.05	0.1	NC		NC		NC	
Herring (unident)	NC		NC		NC		NC		NC		NC		NC		0.10	0.3	0.05	0.2
Hogchoker	NC		0.10		NC		1.80	3.7	0.40	1.3	1.10	2.9	0.10	0.4	0.20	0.9	0.15	0.5
Largemouth bass	0.10	0.3	2.70	0.3	0.10	0.5	NC		NC		NC		NC		NC		NC	
Pumpkinseed	2.60	12.0	0.30	12.7	2.65	12.2	7.10	14.6	3.70	13.2	5.40	14.1	0.60	1.6	0.80	3.2	0.70	2.2
Redbreast sunfish	NC		3.10	1.3	0.15	0.7	NC		NC		NC		NC		NC		NC	
Spottail shiner	1.30	5.8	NC	14.7	2.20	10.2	0.70	1.5	0.10	0.3	0.40	1.1	0.90	2.2	0.30	1.2	0.60	1.9
Tessellated darter	0.20	1.0	NC		0.10	0.5	0.60	1.2	0.10	0.5	0.35	0.9	0.10	0.2	0.10	0.3	0.10	0.3
Tidewater silverside	0.10	0.3	0.10		0.05	0.2	NC		NC		NC		NC		NC		NC	
White catfish	NC		9.50	0.3	0.05	0.2	0.10	0.3	NC		0.05	0.1	NC		NC		NC	
White perch	10.70	48.7	2.70	44.5	10.10	46.7	19.40	40.0	17.60	62.5	18.50	48.4	26.70	68.1	16.60	68.4	21.65	68.2
Yellow perch	3.70	16.9		12.7	3.20	14.8	6.00	12.4	2.20	7.8	4.10	10.7	7.10	18.2	4.50	18.6	5.70	17.9
Total mean catch	22.00		21.40		21.65		48.40		28.20		38.25		39.20		24.20		31.70	
Total No. Species	12		13		16		13		13		16		12		13		NC	

*Mean CPUE represents mean CPUE of 7 nonconsecutive days of duplicate samples collected at each station on low and high tides.

**Mean catch (tides combined) represents the mean of mean CPUEs summed across tides at each station.

NC = No Catch.

Sampling for the spring 1980 season was completed over the regularly scheduled 7 sampling days. Catches were sufficient to support analysis of the following species/catch categories: 1) white perch density, 2) pumpkinseed density, 3) yellow perch density, 4) total density. The densities (CPUE) were transformed by $\log_e$ (density + 1) to stabilize the variances for the analysis of variance. The results of these analyses of variance are summarized in Table 3-22. The hypothesis of equal area means was rejected at the $\alpha = 0.05$ level of significance for white perch and pumpkinseed densities. Likewise, the hypothesis of equal area means for total density was rejected at the $\alpha = 0.06$ level of significance.

Table 3-22

Analysis of Variance Results for Spring Trawl Catch

Source of Variation	Degrees of Freedom	White Perch		Yellow Perch		Pumpkinseed		Total Density	
		Sum of Squares	$P_r > F$	Sum of Squares	$P_r > F$	Sum of Squares	$P_r > F$	Sum of Squares	$P_r > F$
Day	6	12.58		11.73		5.02		16.37	
Area	2	10.41	0.01	3.90	0.12	10.93	0.01	6.22	0.06
Day x Area	12	9.67	0.07	9.20		8.97		10.40	
Tide	1	1.06	0.28	3.65	0.09	0.58	0.28	1.37	0.15
Day x Tide	6	4.51		5.22		2.44		2.94	
Area x Tide	2	0.52	0.47	2.24	0.22	0.69	0.45	1.30	0.06
Day x Area x Tide	12	3.85	0.65	7.85	0.08	4.84	0.18	2.21	0.80
Residual	42	16.77		15.16		11.68		12.10	
Corrected Total	83	59.36		58.95		45.14		52.90	

Duncan's multiple range test was used to discriminate among the area means for species whose F-test was significant. The results are given in Table 3-23. For white perch, mean catches at the always-affected area were significantly smaller than mean catches at the sometimes- and never-affected areas (Figure 3-5), suggesting possible thermal preference or exclusion of white perch from the area of the discharge during this species' spawning season. For pumpkinseed, mean CPUE was significantly smaller at the never-affected area than at the always- or sometimes-affected areas, suggesting possible attraction or thermal preference for warmer waters during the spring season. For total density, a somewhat different effect was observed. Mean catches at the sometimes- and always-affected areas were statistically different; however, the mean CPUE at the never-affected area was not found to be statistically different from either the sometimes- or always-affected area.

Table 3-23

Duncan's Multiple Range Test at $\alpha = 0.05$ for White Perch, Pumpkinseed, and Total Density Area Means

	Grouping	Mean	N	Area
White Perch	A	2.94	28	Sometimes affected
	A	2.77	28	Never affected
	B	2.12	28	Always affected
Pumpkinseed	A	1.13	28	Sometimes affected
	A	1.06	28	Always affected
	B	0.33	28	Never affected
Total Density	A	3.47	28	Sometimes affected
	A B	3.23	28	Never affected
	B	2.81	28	Always affected

There was a significant difference in the means of the area-by-tide interaction for total density (Table 3-22). The hypothesis of equal area-by-tide changes in mean values was rejected at the $\alpha = 0.06$ level of significance. At low tide in the sometimes- and never-affected areas there were proportional increases in mean CPUE over that at high tide (Figure 3-6). However, in the always-affected area there was a slight decline in mean CPUE at low tide over that at high tide.

Seine

Seine sampling during April 1980 collected primarily resident bay species such as tidewater silverside, white perch, Atlantic silverside, and banded killifish as well as the seasonal migrant Atlantic menhaden (30 individuals, 3 percent) and the anadromous blueback herring (192 individuals, 19 percent) (Table 3-20).

Somewhat higher catches and species numbers were recorded on high tide than on low tide (546 individuals and 22 species high tide; 462 individuals and 21 species low tide) due primarily to large single catches of

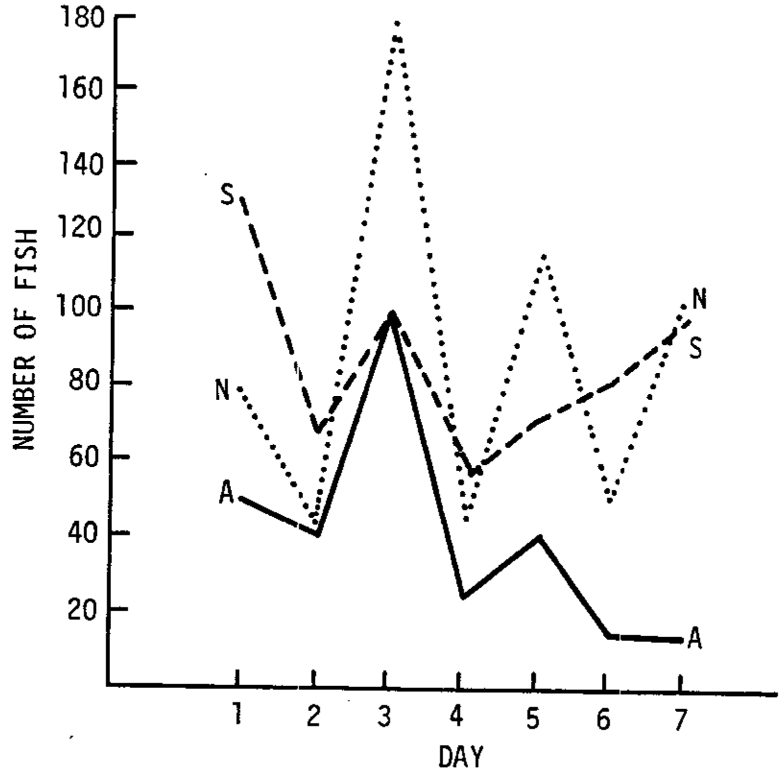

Figure 3-5. Day-by-Area Interaction Plot (Spring) for White Perch

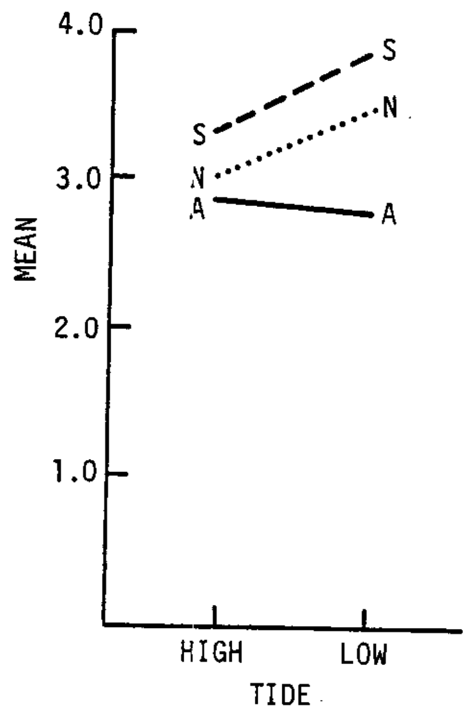

Figure 3-6. Area-by-Tide Interaction Plot (Spring) for Total Density

blueback herring on high tide at Battery Point station 05 (Table 3-21 and appendix Table A-10). Examination of individual station catches revealed larger high-tide catches at Saltpeter Creek discharge station 03 and Battery Point station 05 and smaller high-tide catches at sometimes-affected Saltpeter Creek mouth station 04 (Table 3-24).

Seine CPUE at thermal discharge station 03 declined from a peak value on the first sampling date (91 individuals) through the fifth sampling date (five individuals) and rose on the last two sampling excursions. Catches at sometimes- and never-affected stations 04 and 05 fluctuated during the study period, and no distinct abundance trend was observed (appendix Table A-10). The pattern of cyclic fluctuations in white perch and to a lesser extent in yellow perch catches observed in spring trawling was not evident in spring seine catches.

Seines

Seine sampling for the spring season was completed over the seven regularly scheduled sampling days. Catches were sufficient to support analysis of the following species/catch categories: 1) white perch, 2) banded killifish, 3) tidewater silverside, 4) mummichog, 5) total density. Densities (CPUE) were transformed by $\log_e$ (density + 1) to stabilize the variances for the analysis of variance. The results of these analyses of variance are summarized in Table 3-25.

The hypothesis of equal area means was rejected at the $\alpha = 0.05$ level of significance for white perch and banded killifish. Likewise, the hypothesis of equal area-by-tide means was rejected at the $\alpha = 0.05$ level of significance for banded killifish only. Duncan's multiple range test was used to discriminate among the area and tide means. The results are given in Table 3-26. For banded killifish, mean catches at the never-affected area were significantly smaller than those obtained at the always- and sometimes-affected areas. Further, the mean catches of banded killifish obtained at low tide were significantly larger than those at high tide. These results when coupled with similar findings for this species during winter suggest that banded killifish prefer/are attracted to the warmer waters in the plume area during winter

Table 3-24

Total Mean Catch per Unit Effort (CPUE)* for Fishes Collected by Beach Seine at Stations in the Vicinity of C.P. Crane Generating Station, Spring Season 1980

	Station 03 (Discharge)						Station 04 (Saltpeter Creek Mouth)						Station 05 (Battery Point)					
	CPUE				Mean Catch**		CPUE				Mean Catch		CPUE				Mean Catch	
Species	Low	%	High	%	Tides Combined	%	Low	%	High	%	Tides Combined	%	Low	%	High	%	Tides Combined	%
Alewife									0.10	1.4	0.05	0.6						
American eel	0.10	0.7	0.40	2.7	0.25	2.1	0.30	2.2			0.15	1.7	0.10	1.5	0.40	1.7	0.25	1.7
Atlantic menhaden	0.10	0.7	0.60	4.9	0.35	2.9	0.20	1.6	0.70	14.5	0.45	5.1	0.10	0.8	0.40	2.0	0.25	1.7
Atlantic silverside	0.50	4.7			0.25	2.1	1.10	8.8	0.60	11.6	0.85	9.6			1.50	7.2	0.74	4.9
Banded killifish	1.60	14.7	0.50	3.8	1.05	8.8	1.30	9.9	0.20	4.3	0.75	8.4	0.10	1.5	0.10	0.7	0.10	0.7
Bay anchovy							0.10	0.5	0.30	5.8	0.20	2.2						
Blueback herring													0.30	3.1	13.4	64.2	6.85	45.2
Bluegill							0.10	1.1	0.10	1.4	0.10	1.1	0.10	0.8			0.05	0.3
Brown bullhead			0.10	0.5	0.05	0.4												
Carp							0.10	0.5			0.05	0.6			0.10	0.3	0.05	0.3
Catfish (unident.)			0.10	1.1	0.05	0.4												
Gizzard shad			0.40	3.3	0.20	1.7							0.10	0.8	0.10	0.3	0.10	0.7
Golden shiner	0.10	0.7			0.05	0.4												
Herring (unident.)			0.10	0.5	0.05	0.4	0.40	3.3	0.10	2.9	0.25	2.8	0.30	3.1			0.15	1.0
Largemouth bass			0.10	1.1	0.05	0.4							0.10	0.8	0.10	0.3	0.10	0.7
Mummichog	1.10	10.0	0.60	4.3	0.85	7.0	0.10	1.1	0.10	2.9	0.10	1.1	0.10	0.8	0.30	1.4	0.20	1.3
Pumpkinseed	0.30	2.7	0.10	1.1	0.20	1.7	0.40	3.3	0.20	4.3	0.30	3.3						
Rainbow smelt			0.10	0.5	0.05	0.4							0.20	2.3	0.10	0.3	0.15	1.0
Rough silverside	0.60	6.0	0.10	0.5	0.35	2.9	0.80	6.0			0.40	4.5	1.20	13.1			0.60	4.0
Spottail shiner	0.40	4.0	0.60	4.9	0.50	4.2	0.80	6.0	0.10	2.9	0.45	5.1	0.60	6.9	0.20	1.0	0.40	2.6
Tessellated darter	0.20	2.0			0.10	0.8	0.20	1.6			0.10	1.1						
Tidewater silverside	5.6	52.0	7.50	57.1	6.55	55.0	2.40	18.7	1.80	36.2	2.10	23.6	3.90	42.3	1.90	8.9	2.90	19.0
White perch	0.10	1.3	1.60	12.5	0.85	7.0	4.40	33.5	0.60	11.6	2.50	28.1	2.00	21.5	2.20	10.6	2.10	13.9
Yellow perch	0.10	0.7	0.10	1.1	0.10	0.8	0.20	1.6			0.10	1.1	0.10	0.8	0.20	1.0	0.15	1.0
Total mean catch	10.70		13.10		11.90		13.00		4.90		8.90		9.30		20.9		15.15	
Total No. species	13		16		19		16		12		17		15		14		17	

*Mean CPUE represents mean CPUE of 7 nonconsecutive days of duplicate samples collected at each station on low and high tides.

**Mean catch (tides combined) represents the mean of mean CPUE's summed across tides at each station.

and early spring months. Mean catches of white perch at the never-affected area were significantly larger than those obtained at the always-affected area, again suggesting avoidance of the immediate discharge area during the spring spawning season. However, mean catches obtained at the sometimes-affected area differed statistically from those obtained at either the never- or always-affected area.

Table 3-25

Analysis of Variance Results for Spring Seine Catch

Source of Variation	Degrees of Freedom	White Perch Sum of Squares	White Perch $P_r > F$	Banded Killifish Sum of Squares	Banded Killifish $P_r > F$	Tidewater Silverside Sum of Squares	Tidewater Silverside $P_r > F$	Mummichog Sum of Squares	Mummichog $P_r > F$	Total Density Sum of Squares	Total Density $P_r > F$
Day	6	2.33		2.42		21.34		1.17		24.54	
Area	2	5.41	0.06	2.59	<0.01	3.45	0.33	1.61	0.08	0.13	0.96
Day x Area	12	8.81		1.73		17.40		3.09		21.29	
Tide	1	0.02	0.75	1.70	0.03	0.19	0.75	0.07	0.65	0.16	0.82
Day x Tide	6	1.00		1.37		10.23		1.89		17.85	
Area x Tide	2	3.42	0.06	0.86	0.07	0.07	0.96	0.36	0.42	6.22	0.14
Day x Area x Tide	12	5.88	0.56	1.52	0.94	11.74	0.36	2.36	0.18	16.35	0.43
Residual	42	22.87		11.98		36.36		5.67		54.97	
Corrected Total	83	49.74		24.15		100.81		16.23		141.52	

Table 3-26

Duncan's Multiple Range Test at $\alpha = 0.05$ for White Perch and Banded Killifish Area Means and Banded Killifish Tide Means

	Grouping		Mean	N	Area
Banded Killifish (Area Means)	A		0.50	28	Always affected
	A		0.36	28	Sometimes affected
		B	0.08	28	Never affected
White Perch (Area Means)	A		0.86	28	Never affected
	A	B	0.65	28	Sometimes affected
		B	0.25	28	Always affected
Banded Killifish (Tide Means)	A		0.46	42	Low
		B	0.17	42	High

The test of no interaction between the area and tide means was rejected for white perch and total density, indicating that differences between area means were not consistent at high and low tides. In Figure 3-7, decreases in mean catches of white perch at the never- and always-affected areas were consistent across tides. However, mean catch in the sometimes-affected area was decidedly higher at low tide than at high tide. Figure 3-8 for total density shows a corresponding increase in mean catches at low tide for the always- and sometimes-affected areas over those obtained at high tide. However, there was no change in mean catches for the never-affected area across tides.

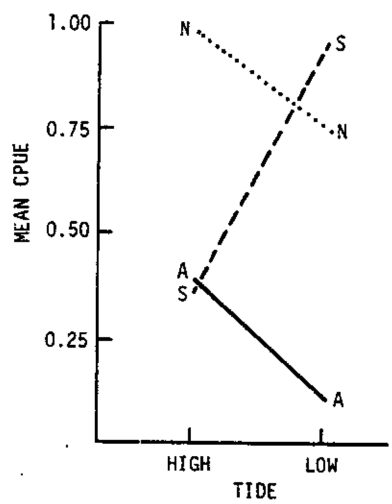

Figure 3-7. Area-by-Tide Interaction Plot for White Perch CPUE by Seine, Spring Season 1980

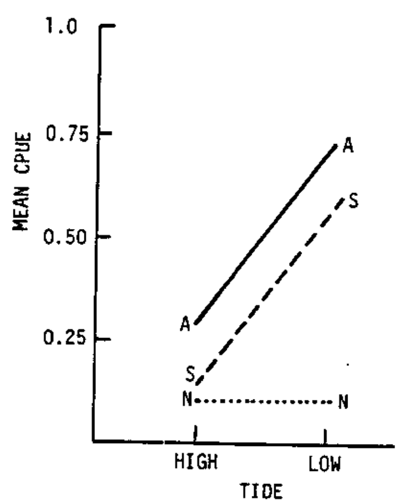

Figure 3-8. Area-by-Tide Interaction Plot for Banded Killifish CPUE by Seine, Spring Season 1980

d. Complete Model

Trawls

The unbalanced, cross-classified, nested analysis of variance model (CCNAOV) was used to analyze all the trawl data obtained for total fish density and for white perch density (the only fish species with sufficient catches during each season to support analysis). Densities (CPUE) were transformed by $\log_e$ (density + 1) for the CCNAOV. The results of these analyses of variance are summarized in Table 3-27.

Table 3-27

Complete Model Analysis of Variance for Trawl Data, Seasons Combined

Source of Variation	Degrees of Freedom	White Perch Sum of Squares	White Perch $P_r > F$	Total Density Sum of Squares	Total Density $P_r > F$
Season	2	209.60	<0.01	377.22	<0.01
Area	2	24.49	<0.01	1.22	0.67
Season x Area	4	96.84	<0.01	14.15	0.08
Day (Season)	16	35.16		27.39	
Area x Day (Season)	32	29.73		48.53	
Tide	1	1.18	0.29	2.00	0.06
Season x Tide	2	0.22	0.90	0.19	0.83
Area x Tide	2	1.41	0.09	0.89	0.26
Season x Area x Tide	4	0.72	0.62	5.71	<0.01
Tide x Day (Season)	16	15.43		8.06	
Area x Tide x Day (Season)	32	8.68		9.97	
Residual	114	40.15		27.61	
Corrected Total	227	463.61		522.93	

The hypotheses of equal season and area means were rejected for white perch at the $\alpha = 0.05$ level of significance. Duncan's multiple range test was used to discriminate among the season and area means for white perch. The results are given in Table 3-28. Mean catches for spring were significantly larger than mean catches for summer, and mean catches were significantly larger for summer than for winter. Hence, three separate groupings were given to seasons. In addition, mean catches of white perch for the always-affected area were significantly larger than mean catches in the never- and sometimes-affected areas, suggesting an overall attraction/ preference of this species for the heated waters in the vicinity of the C.P. Crane thermal discharge.

Table 3-28

Duncan's Multiple Range Test at $\alpha = 0.05$ for White Perch Area and Season Means and Total Density Means of Trawl Catch Data

	Grouping	Mean	N	Season	Area
Season (White Perch)	A	2.61	84	Spring	NA
	B	1.80	84	Summer	NA
	C	0.18	60	Winter	NA
Area (White Perch)	A	2.13	76	NA	Always affected
	B	1.46	76	NA	Never affected
	B	1.37	76	NA	Sometimes affected
Season (Total Density)	A	4.55	84	Summer	NA
	B	3.17	84	Spring	NA
	C	1.27	60	Winter	NA

NA = Not applicable.

CPUE for white perch also displayed a significant season-by-area interaction. The hypothesis of equal changes in area means by season was rejected at the $\alpha = 0.05$ level of significance. A plot of the season-by-area interaction is given in Figure 3-9. The mean CPUE for the winter season was extremely small and consequently had little effect on the season-by-area interaction. Moreover, white perch were decidedly attracted to the thermal effluent in summer, whereas they showed a significant decrease in density (avoidance) at the always-heated area (thermal discharge station 03) during the spring spawning season.

The hypothesis of equal season means for total density was rejected at the $\alpha = 0.05$ level of significance. Mean catches for the summer season were significantly larger than mean catches for the spring season. Furthermore, mean catches for the spring season were significantly larger than the mean catches for the winter season. Thus, there were three separate groupings of seasons for total density (CPUE).

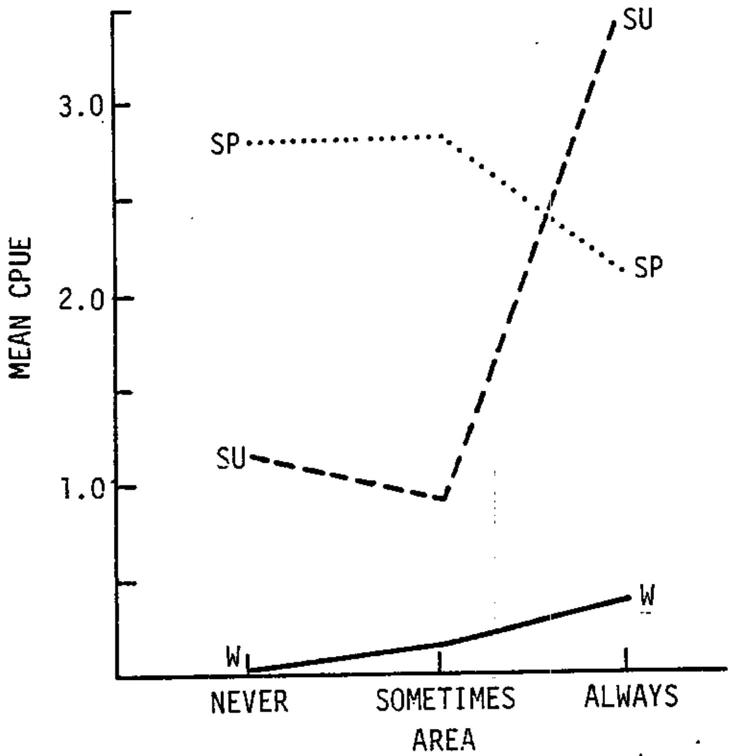

Figure 3-9. Season-by-Area Interaction Plot for White Perch CPUE by Trawl

The test of no interaction between the area and tide means for total density was significant at the $\alpha = 0.05$ level. A plot of the area-by-tide interaction for total density is given in Figure 3-10. This figure clearly shows little difference in mean catch at the always-affected area for high and low tides. However, the never-affected and sometimes-affected areas had larger mean catches at low tides than at high tides in the same areas.

The test of no interaction between the season and area means for total density was significant at the $\alpha = 0.08$ level. A plot of the season-by-area interaction for total density is given in Figure 3-11. From the graph it is evident that the changes in area means across seasons were approximately the same for the never- and sometimes-affected areas. However, the difference in the always-affected area means decreased correspondingly from the summer to the winter season.

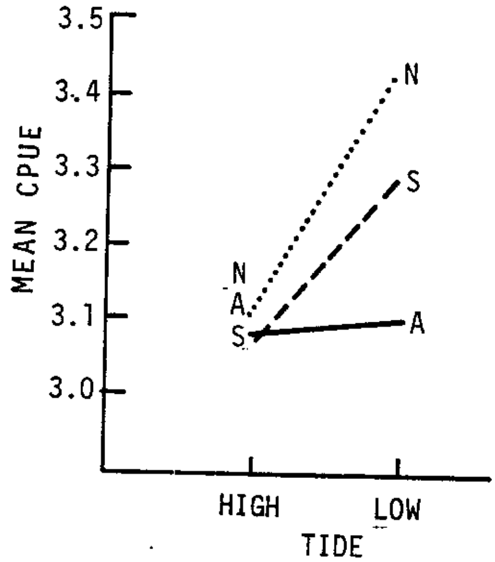

Figure 3-10. Area-by-Tide Interaction Plot of Total CPUE by Trawl, All Seasons Combined

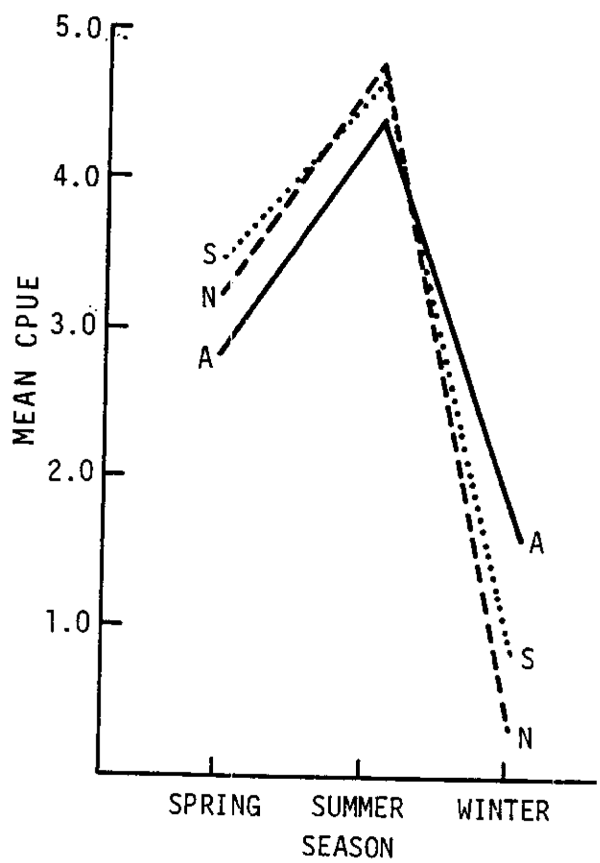

Figure 3-11. Season-by-Area Interaction Plot of Total CPUE by Trawl

Seines

The unbalanced, cross-classified, nested analysis of variance model (CCNAOV) was used to analyze all the seine data for white perch density, mummichog density, and total fish density. Densities (CPUE) were transformed by $\log_e$ (density + 1) for the CCNAOV. The results of these analyses of variance are summarized in Table 3-29.

Table 3-29

Complete Model Analysis of Variance for Seine Data

Source of Variation	Degrees of Freedom	White Perch Sum of Squares	White Perch $P_r > F$	Mummichog Sum of Squares	Mummichog $P_r > F$	Total Density Sum of Squares	Total Density $P_r > F$
Season	2	26.58	<0.01	0.71	0.21	257.21	<0.01
Area	2	10.70	<0.01	2.83	<0.01	1.76	0.51
Season x Area	4	11.51	<0.01	0.42	0.63	4.79	0.45
Day (Season)	16	6.50		3.33		32.71	
Area x Day (Season)	32	19.64		5.17		40.81	
Tide	1	0.22	0.21	0.11	0.37	0.32	0.63
Season x Tide	2	0.64	0.12	0.04	0.86	0.27	0.90
Area x Tide	2	2.15	0.06	0.20	0.30	8.13	0.02
Season x Area x Tide	4	2.74	0.12	0.28	0.50	7.81	0.11
Tide x Day (Season)	16	2.08		2.10		20.78	
Area x Tide x Day (Season)	32	10.91	0.45	2.59	0.74	30.69	0.06
Residual	114	37.95		11.33		72.79	
Corrected Total	227	131.61		29.10		478.07	

The hypothesis of equal season means was rejected at the $\alpha = 0.05$ level of significance for white perch and total density. The hypothesis of equal area means was rejected at the $\alpha = 0.05$ level of significance for white perch and mummichog density. Duncan's multiple range test was used to discriminate among the season and area means for the categories. The results are given in Table 3-30. For white perch and total density, summer mean catches were significantly larger than spring mean catches. Also, for white perch and total density, spring mean catches were significantly larger than winter mean catches. Thus, three separate groupings were given to seasons for white perch and total density. Mean catches of white perch in the never-affected area were significantly larger than those obtained at either the always- or sometimes-affected area, suggesting an overall avoidance or exclusion from thermally influenced shore-zone waters in the study area. Additionally, for mummichog density, mean catches for the always-affected area were significantly larger than those at either the sometimes- or never-affected area, suggesting an overall pattern of attraction to the heated shore-zone waters in the immediate vicinity of the C.P. Crane thermal discharge.

Table 3-30

Duncan's Multiple Range Test at $\alpha = 0.05$ for White Perch Season and Area Means, Mummichog Area Means, and Total Density Season Means of Seine Catches

	Grouping	Mean	N	Season	Area
Season (White Perch)	A	0.87	84	Summer	NA
	B	0.58	84	Spring	NA
	C	0.00	60	Winter	NA
Area (White Perch)	A	0.84	76	NA	Never affected
	B	0.40	76	NA	Always affected
	B	0.36	76	NA	Sometimes affected
Area (Mummichog)	A	0.28	76	NA	Always affected
	B	0.07	76	NA	Sometimes affected
	B	0.03	76	NA	Never affected
Season (Total Density)	A B C	3.07	84	Summer	NA
		1.67	84	Spring	NA
		0.38	60	Winter	NA

NA = Not applicable.

CPUE for white perch also displayed a significant season-by-area interaction. The hypothesis of equal differences in area means by season was rejected at the $\alpha = 0.05$ level of significance. A plot of the season-by-area interaction for white perch is given in Figure 3-12. The interaction is due to the decrease in mean catches of white perch across seasons in the sometimes-affected areas. For the never- and always-affected areas, the mean catches increased from spring to summer and decreased from summer to winter.

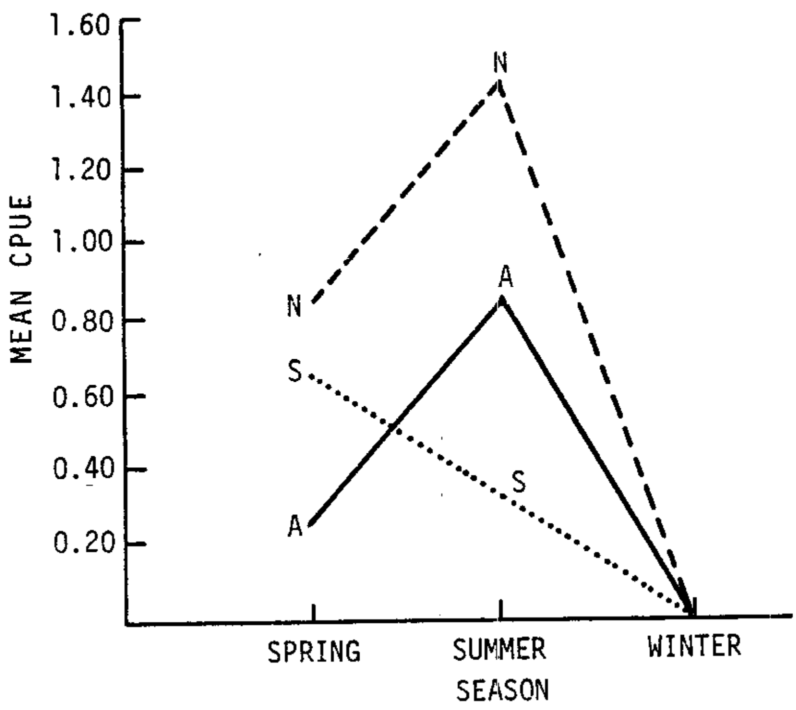

Figure 3-12. Season-by-Area Interaction Plot of White Perch CPUE by Seine

The hypothesis of equal differences in area means by tide was rejected at the $\alpha = 0.05$ level of significance for white perch and total density (Figures 3-13 and 3-14). For white perch, mean catches at high tide were decidedly larger than those at low tide. Mean catches for the sometimes-affected areas at high tide were significantly smaller than those at low tide, whereas the mean catches for the never-affected area were about the same for both tides. The same type of phenomenon occurred for total density, although mean catches for each season-area cell were more nearly equal than those for white perch. The mean catch for the always-affected area was decidedly smaller at low tide than at high tide. The mean catch for the sometimes-affected area was significantly larger at high tide than at low tide, whereas the mean catches for the never-affected area were about the same for each tide.

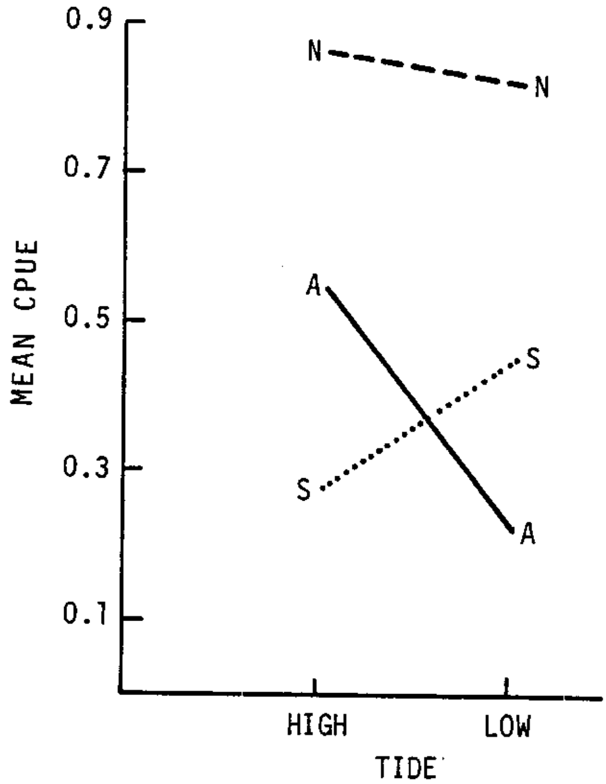

Figure 3-13. Area-by-Tide Interaction Plot of White Perch CPUE by Seine

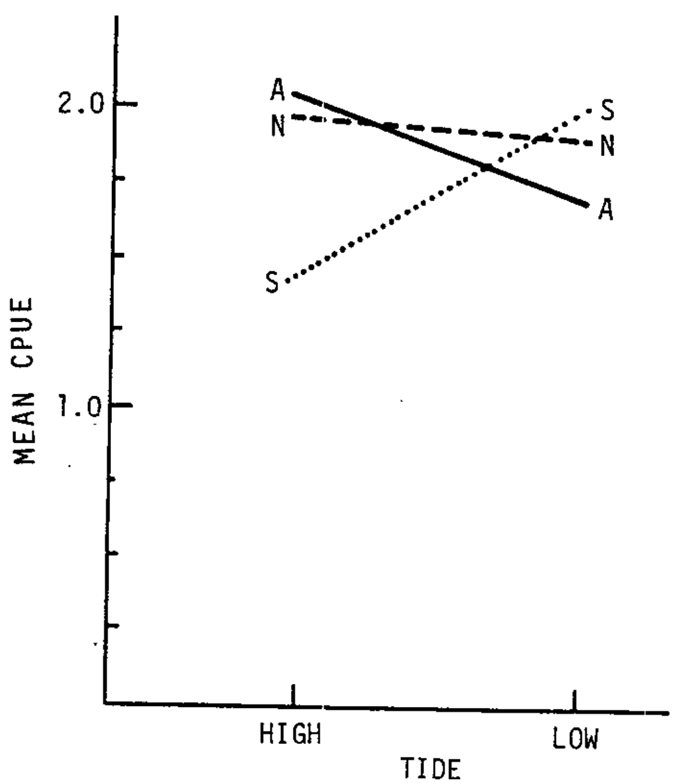

Figure 3-14. Area-by-Tide Interaction Plot of Total CPUE by Seine

B. PARASITE ANALYSES

1. Zooplankton Sampling

Plankton net samples were collected concurrently with trawling during 1979-1980 to evaluate water column densities of the parasitic copepods *Ergasilus* and *Argulus* as they related to parasitic infestation levels in thermally affected and nonaffected areas in the C.P. Crane plant vicinity. Seasonal mean densities of *Ergasilus* and *Argulus* collected in these areas appear in Table 3-31. Mean station/tide densities encountered on each sampling date are presented in appendix tables A-11 through A-13.

Table 3-31

Seasonal Mean Densities (No./m^3) of *Ergasilus* and *Argulus* Collected by 0.5-Meter Plankton Net in the Vicinity of C.P. Crane Generating Station, 1979-80

		Station								
		3		4		5		Site $\bar{x}$		Site $\bar{x}$
Season	Taxa	Low**	High	Low	High	Low	High	Low	High	Combined
Summer Jul-Aug 1979	Copepoda Cyclopoida *Ergasilus* spp.	2.02	3.10	3.23	2.33	3.85	2.72	3.04	2.71	2.88
	Branchiura Argulidae *Argulus alosae*	0.61	0.49	0.48	0.50	0.64	0.46	0.58	0.49	0.53
Winter Jan 1980	Copepoda Cyclopoida *Ergasilus* spp.	NC	NC	NC	NC	0.01	NC	0.00	0.00	0.00
	Branchiura Argulidae *Argulus alosae*	0.02	NC	NC	NC	NC	NC	0.00	0.00	0.00
Spring Apr 1980	Copepoda Cyclopoida *Ergasilus* spp.	1.24	1.64	2.63	2.67	2.54	2.89	2.13	2.40	2.27
	Branchiura Argulidae *Argulus alosae*	NC	0.10	NC	NC	NC	NC	NC	0.03	0.02

*Values are means of daily mean densities of duplicate samples collected for 7 nonconsecutive days (Summer, Spring) or 5 nonconsecutive days (Winter) on each tide at each station.

**Low and High = tide stage.

Ergasilus spp., represented by *E. cerastes*, *E. lizae*, and *E. labracis*, were distributed relatively uniformly throughout the study area, averaging 2.9 organisms/m^3 of water sampled during the summer 1979 season. Densities were slightly higher on low tide at Saltpeter Creek mouth (3.2 organisms/m^3) and Battery Point (3.9 organisms/m^3) but greatest on high tide (3.1 organisms/m^3) in the vicinity of the thermal discharge. Mean total density of *Ergasilus* spp. (tides combined) was highest at Battery Point (3.2 organisms/m^3) and lowest in the Saltpeter Creek discharge area (2.6 organisms/m^3) (Table 3-31).

Comparison of 1979 summer samples with data collected by Grant and Berkowitz (1979a) during summer 1978 revealed a somewhat lower mean *Ergasilus* density during August 1979 (2.9 organisms/m^3) than observed during August 1978 (5.6 organisms/m^3), but apparently higher than those observed by Grant et al (1980) during July and August 1979; no density estimates were provided in this 1980 report for comparison purposes. This difference can be explained by differences in sampling years, differing sampling gear sizes and efficiencies, stations sampled and included in the mean, and the fact that only potentially parasitic female *Ergasilus* were enumerated during the present TI survey.

As expected, *Ergasilus* spp. densities diminished greatly in the C.P. Crane study area during the January 1980 (winter) season. *Ergasilus* spp. were collected on only one sampling date (14 January), at Gunpowder River station 05 on low tide (0.01 organism/m^3). Grant et al (1980) of VIMS collected no *Ergasilus* in 202-micron mesh net samples during January 1980 zooplankton sampling in the study area. *Ergasilus* spp. densities in the study area approached summer 1979 levels during mid- to late April 1980, averaging 2.3 organisms/m^3 of water sampled. Densities were relatively uniform on high and low tides at Saltpeter Creek mouth (2.6/m^3 at low tide, 2.7/m^3 at high tide) and Gunpowder River/Battery Point (2.5/m^3 at low tide, 2.9/m^3 at high tide) but were apparently lower in the area of the thermal discharge (1.2/m^3 at low tide, 1.6/m^3 at high tide) (Table 3-31).

Data collected by VIMS (Grant and Berkowitz, 1979b) during spring 1979 in the Crane study area indicated that Ergasilus were rare or absent in their collections until May and June, when they began to appear in greater abundance. April density levels were not available in their report for comparison purposes. During May and June, VIMS collected Ergasilus cerastes at all locations except the uppermost Gunpowder River and outermost river stations, while Ergasilus chautauquaensis (suggested as probably free-living) were collected predominantly in the immediate intake area (Seneca Creek) and in discharge waters (Saltpeter Creek) in the vicinity of the C.P. Crane plant. Mean summer densities of 5.6 organisms/m^3 were recorded in the study area during 1978, ranking Ergasilus as one of the dominant five taxa in an "atypically" structured summer zooplankton community (Grant and Berkowitz, 1979a).

Ecological Analysts, Inc. (EA) (1980) noted that Ergasilus were occasionally taken in plankton samples and recorded overall mean densities of 6.8/m^3 (80-micron mesh net), 7.9/m^3 (153-micron mesh net), and $3.0 \times 10^{-5}/m^3$ (505-micron mesh net) in near- and farfield regions of the C.P. Crane study area. Occurrences of Ergasilus spp. were sporadic and discontinuous in 80-micron mesh net catches, occurring in January in the upper and lower Gunpowder River, in April and June in Seneca and Saltpeter creeks respectively, and throughout the area during late summer; catches diminished during September and November. Ergasilus did not occur in 153-micron mesh net samples until May 1979 and were present in low densities until August, when peak seasonal values were recorded in the upper Gunpowder River and upper Dundee Creek. As observed for 80-micron mesh nets, densities declined through the late fall.

The present study found Argulus spp., represented by A. alosae, uniformly distributed over the study area during summer 1979, averaging 0.53 organism/m^3 of water sampled. Densities were greatest on low tide (0.61 organism/m^3) at Saltpeter Creek discharge and Battery Point (0.64 organism/m^3) and highest on high tide at Saltpeter Creek mouth (0.50 organism/m^3). Mean total density of Argulus spp. (tides combined) was identical for Saltpeter Creek discharge and Battery Point areas (0.55 organism/m^3) and averaged 0.49 organism/m^3 at Saltpeter Creek mouth (Table 3-31).

The mean Argulus density observed during summer 1979 (0.53 organism/m^3) was also somewhat lower than August densities encountered by VIMS (Grant and Berkowitz, 1979a) during summer 1978 (1.2 organisms/m^3) and was actually more in line with September 1978 densities (0.5 organism/m^3), and comparable to July and August 1979 densities (0.9 and 0.3 organisms/m^3, respectively) reported by Grant et al (1980). This approximate two-fold difference may also be explained by differences in sampling years and in stations sampled and used to create the mean value.

Argulus alosae were collected on only the first sampling date of the winter season (14 January), at Saltpeter Creek thermal discharge station 03 on low tide (0.02 organism/m^3) (Table A-12). Their population had not yet recovered from winter stock depletions by April 1980. They were encountered in plankton samples only on a single sampling date (18 April) (Table 3-31), on low tide at Saltpeter Creek thermal discharge station 03 (0.7 organism/m^3) (Table A-13).

VIMS (Grant and Berkowitz 1979a, Grant et al 1980) data revealed that Argulus in the C.P. Crane study area were rare or absent in collections until May and June, when they began to appear in greater abundance. During spring 1979, Argulus alosae appeared only in catches from the Chesapeake Bay side of the study area, suggesting seasonal recruitment from bay waters. Catches taken during summer 1978 revealed Argulus to be one of the five dominant taxa in an "atypically" structured summer zooplankton community.

Overall mean densities of Argulus reported by EA (1980) were 0.75/m^3 and 0.10/m^3 for 153-micron and 505-micron mesh nets respectively during 1974. Argulus catches for 153-micron mesh nets were low during June 1979, peaked in July at the mouth of Seneca Creek, declined during early fall, and disappeared after October.

Data from 505-micron mesh net catches revealed a relatively continuous Argulus distribution in the C.P. Crane study area, with specimens collected from June through November 1979. Peak abundances for the June-October period occurred from upper Dundee Creek out through Saltpeter Creek to the waters off Carroll Island. Maximum mean Argulus densities were recorded in

July at the confluence of Saltpeter and Dundee creeks for 505-micron mesh nets and at the mouth of Seneca Creek for 153-micron mesh nets. Densities declined throughout the study area during fall and were uniformly reduced at all sampling locations by November 1979 (EA 1980).

The combined results of zooplankton surveys in the nearfield and farfield vicinities of the C.P. Crane Generating Station reveal comparable densities among studies and a widespread seasonal distribution pattern for parasitic copepods *Ergasilus* spp. and *Argulus alosae*, which occur within the study area from January through November. Abundances appear to follow a typical cyclic pattern positively correlated with water temperature, displaying discontinuous and infrequent abundance during winter, early spring, and late fall (November through April), increasing densities throughout the study area to peak abundances in July-August, and uniform though declining densities during September and October. Data from past studies and the present survey indicate no consistent trend of increased parasite densities in the vicinity of the C.P. Crane thermal discharge.

Although the present study did not determine relative abundance for all zooplankton collected, previous studies by VIMS (Grant and Berkowitz 1979a and b) revealed that *Argulus* and *Ergasilus* accounted for two of the five dominant mezo-zooplankton taxa in the study area and as such represented important components of an apparently "atypically" structured zooplankton community. Ecological Analysts (EA) (1980), however, found that *Ergasilus* accounted for no more than 0.25 percent of the total zooplankton catch, even during its month of peak abundance (August), while *Argulus* during its peak month accounted for no more than 0.06 percent of the zooplankton. Their findings indicated that these two parasites are relatively unimportant contributors to the total zooplankton community.

2. Parasite/Abnormality Analysis

a. Summer 1979

The same experimental design was used for fish parasite analysis as for trawl and beach seine data, with the following exception. Parasite data were combined over replications to avoid empty cells in the data matrix and so that beach seine parasite data could be incorporated with trawl and zooplankton parasite data. The MANOV test was unaffected by this step, since the area, tide and area-by-tide mean squares were tested by the day-by-area, day-by-tide, and day-by-area-by-tide mean squares, respectively. The variation between replications for a day-by-area-by-tide combination provided an estimate of the residual mean square, which was not used in any of the tests for this study. There was, however, some reduction in power of the tests, since the means of the transformed data for area, tide, and area-by-tide were made up of 14, 21, and 7 observations rather than 28, 42, and 14. The decision to combine over replicates was made to incorporate parasite infestation information provided by the beach seine data, which in a number of instances was too scanty for single gear comparisons, while sacrificing the information provided by residual variability. The data were combined in the sense that the numbers of parasites per fish were averaged over replications and gear, while the proportions of infested fish were obtained by taking the ratio of infested-versus-inspected fish counted across replications and gear. The unequal variances created by combining the data in this manner were not deemed inappropriate since these data were re-expressed by variance-stabilizing transformations and the multivariate analysis of variance technique allows for heteroscedasticity. The only fish present in sufficient numbers for statistical analysis were white perch, spot, and total target fish catch combined. Since the apparent Argulus infestation rate on fish examined was extremely low, only statistical analysis for Ergasilus spp. infested fish was attempted. Low numbers of Argulus found in sample bags and presumed to have fallen off during preservation/handling were not included in the analyses, since they could not be traced to individual specimens. Parasite data for all target species appears in appendix tables A-14 and A-15.

Of the six target species examined, spot was the most often and most heavily parasitized by Ergasilus spp., displaying between 93 and 100 percent infestation occurrence in all three test areas (Table 3-32). Channel catfish ranked second, exhibiting 76 percent infestation at Battery Point (never-affected area) and 83 and 86 percent infestation at Saltpeter Creek discharge and Saltpeter Creek mouth respectively.

Table 3-32

Parasitism Analysis of Key Species Collected* in Vicinity of C.P. Crane Power Station, July-August 1979

Species/Location	No. Examined	Parasite	Site	Severity**	No. Infested	% Infested
White perch						
Discharge	287	*Ergasilus*	Gills	1.0	11	3.8
			Body	1.0	1	<1.0
Creek Mouth	80	*Ergasilus*	Gills	1.5	4	5.0
Battery Point	175	*Ergasilus*	Gills	1.0	1	<1.0
	175	*Argulus*	Gills	1.0	2	1.1
Spot						
Discharge	201	*Ergasilus*	Gills	12.6	188	93.5
		Argulus	Body	1.0	1	<1.0
Creek Mouth	186	*Ergasilus*	Gills	14.9	178	95.6
Battery Point	208	*Ergasilus*	Gills	13.1	208	100.0
Channel catfish						
Discharge	6	*Ergasilus*	Gills	9.8	5	83.3
Creek Mouth	7	*Ergasilus*	Gills	13.3	6	85.7
Battery Point	17	*Ergasilus*	Gills	33.1	13	76.4

*Trawl and seine catch data combined.

**Severity is average number of parasites encountered per fish.

Conversely, white perch exhibited a relatively low infestation rate (0 to 5 percent), with the greatest percentage of those infested occurring at the Saltpeter Creek mouth. Relatively low infestations rates were observed also for yellow perch, pumpkinseed, and mummichog. As noted, the low numbers collected for channel catfish, yellow perch, pumpkinseed, and mummichog precluded statistical analyses of these data for summer 1979.

A small number of white perch (approximately 5 percent of total catch) were observed to have sores or evidence of mechanical abrasion in the area of the caudal peduncle. However, no overt evidence of parasite infestation or disease was noted. No cases of fish malformation (scoliosis, pug-headedness, etc.) were recorded.

As previously noted (Section II), the vector of variables of interest in the detailed parasite analysis were

1) The density (no./m^3) of Ergasilus in the water column as determined by zooplankton sampling

2) The proportion of fish inspected that were infested with Ergasilus

3) The number of Ergasilus per infested fish.

To stabilize the variances for the multivariate analysis of variance, the following transformations were made:

1) Since the Ergasilus density was averaged over the replications, it was multiplied by the square root of the number of tows for the mean.

2) The proportion of fish, P, infested with Ergasilus was transformed to

$$\sqrt{N + 0.5} \text{ arc sine } \sqrt{(P + 3/8)/N + 0.75},$$

where N is the total number of fish inspected for an area-tide date (Anscombe 1948).

3) The number of Ergasilus per infested fish was transformed by $\log_e$ (count + 1).

The probability values of tests using Wilk's lambda are summarized as follows:

	All Fish	White Perch	Spot
Area	0.051	0.389	0.164
Tide	0.632	0.510	0.662
Area x tide	0.561	0.309	0.664

The only hypothesis rejected at the $\alpha = 0.05$ level was that of no overall area effects for all fish (total number examined) combined. Single-degree-of-freedom tests then were performed, comparing the three areas. The probability values associated with the Wilk's lambda for these tests were

Always- vs. Never-Affected	0.045
Always- vs. Sometimes-Affected	0.193
Never- vs. Sometimes-Affected	0.137

These results indicate that the majority of disagreement with the hypothesis of no overall area effects seemed to come from the always- and never-affected areas.

To determine which of the three response variables were affected by area differences, univariate analyses of variance were computed for all fish combined. The probability values of the F-tests were:

	Proportion Infested	*Ergasilus* Density	Number of *Ergasilus* per Infested Fish
Area	0.082	0.432	0.073
Tide	0.709	0.611	0.178
Area x tide	0.654	0.109	0.576

Results indicated that condition or conditions differences (e.g., water temperature) in the always-heated and never-heated areas did not seem to affect the proportion of target species (white perch, spot) infested, the severity of the infestation, or *Ergasilus* densities in the water column but did affect the proportion of total infested fish and the number of *Ergasilus* per infested fish.

Actual area values, as opposed to the transformed values, also illustrate these area differences:

	Always Affected	Never Affected	Sometimes Affected
Proportion of infested fish	0.34	0.51	0.42
Number of *Ergasilus* per infested fish	3.99	7.32	6.39
Ergasilus density	2.56	3.28	2.78

Further examination of parasite analysis data revealed that, overall, a greater proportion of infested and more heavily parasitized fish were collected in the never-affected control area in the Gunpowder River off Battery Point than in the vicinity of the C.P. Crane thermal discharge. This apparent "lessened parasitism effect" observed for catches in the plant discharge vicinity is attributed to the community imbalance created by the apparent thermal exclusion of spot (the most heavily parasitized species) from the discharge area during the summer season (see paragraph III.A.2.a).

b. Winter (January) 1980

Neither fish catches nor zooplankton densities during the winter season were sufficient to support fish parasite statistical analysis. Ergasilus and Argulus parasite data for all target species examined during the winter season appear in Table 3-33 and appendix tables A-16 and A-17. Other observations of overt parasitism and disease are described in subsection III.C.

Of the six target species examined, white perch (17 individuals examined) was the most often and most heavily parasitized by Ergasilus spp. White perch displayed between 75 and 100 percent infestation in the gill area in all three test areas (Table 3-33), 16.7 percent infestation on fin surfaces, and 8 percent infestation on branchiostegal membranes and external maxillary in the vicinity of the thermal discharge. Infestation on gill surfaces was considerably more severe (number of parasites per fish) in the thermal discharge (24.1) than at Saltpeter Creek mouth station 04 (3.7) or Battery Point station 05 (7.0). Based on a sample size of 12 specimens, the severity level observed at thermal discharge station 03 was the highest recorded level for white perch at any station during all three seasons sampled. By comparison, yellow perch (68 individuals examined) were lightly infested, displaying single infestations in the thermal discharge area and at Battery Point and none at Saltpeter Creek mouth. Of the 33 pumpkinseed examined, a single specimen was found to be lightly infested (severity = 1.0) by Ergasilus spp. None of the channel catfish (two individuals), mummichog (four individuals) or carp (11 individuals) examined were parasitized by Ergasilus spp. No infestation by Argulus alosae was observed during winter (January) 1980.

c. Spring (April) 1980

The only fish collected during spring 1980 in sufficient numbers for parasite analysis were white perch and all fish combined. Since the apparent Argulus infestation rate on fish examined was extremely low in the study area during spring 1980, statistical analysis for Ergasilus spp. only was attempted. Since fish were bagged individually in an attempt to alleviate the problem of host abandonment and infestation traceability soon after a fish's removal from

Table 3-33

Parasitism Analysis of Key Species Collected in Vicinity of C.P. Crane Power Station, January 1980

	No. Examined	Parasite	Site	Severity*	No. Infested	% Infested
White Perch						
Discharge	12	Ergasilus	Fins	1.5	2	16.6
			Gills	24.1	12	100.0
			Branchiostegal membrane	2.0	1	8.3
			Maxillary (external)	1.0	1	8.3
Creek Mouth	4	Ergasilus	Gills	3.7	3	75.0
Battery Point	1	Ergasilus	Gills	7.0	1	100.0
Yellow Perch						
Discharge	31	Ergasilus	Gills	1.0	1	3.2
Creek Mouth	16	None				
Battery Point	21	Ergasilus	Gills	1.0	1	4.7
Pumpkinseed						
Discharge	13	None				
Creek Mouth	1	None				
Battery Point	19	Ergasilus	Gills	1.0	1	5.2
Channel Catfish						
Creek Mouth	1	None				
Battery Point	1	None				
Mummichog						
Discharge	3	None				
Creek Mouth	1	None				
Carp						
Discharge	10	None				
Battery Point	1	None				

*Severity = Average number of parasites encountered per fish from the water, we feel that the low Argulus infestation rates observed were representative of actual system levels. Parasite data for all target species appear in Table 3-34 and appendix tables A-18 and A-19.

Table 3-34

Parasitism Analysis of Key Species Collected in Vicinity of C.P. Crane Power Station, April 1980

Species/Location	No. Examined	Parasite	Site	Severity*	No. Infested	% Infested
White perch						
Discharge	150	Ergasilus	Gills	4.8	68	45.3
			Body	1.5	10	6.6
			Maxillary (external)	0.8	2	1.3
			Loose in collection bag	1.8	5	3.3
Creek Mouth	211	Ergasilus	Gills	3.6	121	57.3
			Fins	1.1	3	1.4
			Body	1.1	17	8.0
			Maxillary (external)	1.0	4	1.8
			Loose in collection bag	1.9	11	5.2
		Argulus	Loose in collection bag	1.7	1	0.4
Battery Point	218	Ergasilus	Gills	1.8	95	43.5
			Body	1.4	19	8.7
			Mouth	1.0	2	0.9
			Maxillary (external)	0.7	2	0.9
			Mandible	1.0	2	0.9
			Loose in collection bag	1.6	4	1.8
Yellow perch						
Discharge	79	None				
Creek Mouth	121	None				
Battery Point	164	Ergasilus	Gills	0.9	1	0.6
			Body	0.9	1	0.6
Pumpkinseed						
Discharge	92	Ergasilus	Gills	1.8	4	4.3
Creek Mouth	87	Ergasilus	Gills	1.1	7	8.0
Battery Point	20	Ergasilus	Gills	1.5	2	0.1
Channel catfish						
Discharge	5	None				
Creek Mouth	2	Ergasilus	Gills	1.0	1	50.0
Battery Point	1	None				
Mummichog						
Discharge	21	Ergasilus	Gills	1.0	1	4.7
Creek Mouth	4	None				
Battery Point	5	Ergasilus	Gills	2.0	1	20.0
Carp						
Battery Point	2	None				

*Severity = Average number of parasites encountered per fish.

Of the six target species examined during spring 1980, white perch (579 individuals examined) was the most often and most heavily parasitized by Ergasilus spp., showing between 43 and 57 percent infestation rates in the study area (Table 3-34). Pumpkinseed (199 individuals examined) ranked second, displaying low infestation levels in three test areas. Yellow perch (364 individuals) channel catfish (eight individuals), mummichog (30 individuals), and carp (two individuals) also displayed low levels of parasite infestation (Table 3-34).

As with summer 1979 and winter data, the vector of variables of interest in this analysis were:

- The density of Ergasilus in the water column as collected by the zooplankton tows
- The proportion of the inspected fish infested with Ergasilus
- The number of Ergasilus per infested fish

To stabilize the variances of these variables for the multivariate analysis of variance, the following transformations were made:

- Since the Ergasilus density was averaged over replications, density values were multiplied by the square root of the number of tows for the mean.
- The proportion of fish, P, infested with Ergasilus was transformed to $\sqrt{N+0.5}$ arcsine $\sqrt{(P+3/8)/(N+0.75)}$, where N is the total number of fish inspected for an area-tide date (Anscombe 1948).
- The number of Ergasilus per infested fish was transformed by $\log_e$ (count + 1).

The probability values of tests using Wilk's lambda are summarized as follows:

	All fish	White Perch
Area	0.03	0.03
Tide	0.75	0.73
Area x Tide	0.63	0.62

The only hypothesis for spring 1980 data rejected at the $\alpha = 0.05$ level was that of no overall area effects for white perch and all fish combined. Consequently, single-degree-of-freedom tests were made comparing the three areas. The probability values associated with the Wilk's lambda for these tests were:

Contrast	All Fish	White Perch
Never- vs. Sometimes-Affected	0.4678	0.0973
Always- vs. Sometimes-Affected	0.0703	0.0681
Always- vs. Never-Affected	0.1470	0.4216

Thus, for all fish and white perch, the most significant contrast was between the always-affected station 03, thermal discharge, and the sometimes-affected area, Saltpeter Creek mouth station 04.

To determine which of the three response variables were affected by area differences, univariate analyses of variance were computed for all fish combined and for white perch. The probability of the F-tests are:

All fish	Proportion Infested	Ergasilus Density	Number of Ergasilus per Infested Fish
Area	0.209	0.072	0.035
Tide	0.692	0.637	0.577
Area x Tide	0.523	0.176	0.851

White Perch	Proportion Infested	Ergasilus Density	Number of Ergasilus per Infested Fish
Area	0.190	0.072	0.029
Tide	0.760	0.637	0.512
Area x Tide	0.517	0.176	0.834

These results indicate that environmental conditions within the test areas affected the Ergasilus density in the water column and also the number of Ergasilus per infested fish but not the proportion of infested fish in the total number examined for white perch and for total fish density. The transformed means for white perch directly illustrate the area differences (Table 3-35). This test indicates that there were considerably fewer Ergasilus per infested fish in the never-affected area than in the other areas. Likewise, Ergasilus densities in the sometimes-affected area were significantly greater than in the always- or never-affected area. Although the above test data appear to indicate a greater proportion of infested white perch in the vicinity of the thermal discharge than at sometime- and never-affected areas, results of aforementioned univariate analyses of variance showed that the area term for the proportion infested was not significant at the $\alpha = 0.05$ level of significance.

Table 3-35

Area Affects for White Perch Parasite Data

Variables	Affected Area: Always	Never	Sometimes
Proportion of infested fish	0.56	0.42	0.43
Number of Ergasilus per fish	1.36	1.01	1.26
Ergasilus density	3.49	3.28	4.98

Based on these test data, it appears that during spring 1980, Ergasilus water column densities were significantly greater in the sometimes-affected area (Saltpeter Creek mouth) than in the vicinity of the thermal discharge or at never-affected area (Saltpeter Creek mouth) than in the vicinity of the thermal discharge or at never-affected station 05 (Battery Point). Although the proportion of fish infested by Ergasilus spp. was not significantly different for any station, environmental conditions (possibly water temperature) in the vicinity of the thermal discharge and sometimes-affected areas may be the cause of increased numbers for parasites (i.e., increased severity) per infested fish.

d. Complete Model

A multivariate unbalanced, cross-classified, nested analysis of variance (MCCNAOV) was used to analyze parasite data for trawl and seine catches across all seasons. Parasitism data were combined over replications to avoid having empty cells in the data matrix and to permit beach seine parasite data to be incorporated with trawl and zooplankton parasite data. The only fish species/catch categories present in sufficient numbers of this analysis were white perch and all fish combined. Again, due to the small numbers of Argulus encountered, only Ergasilus was used in these analyses.

The vector of variables of interest in this model were the same as for the summer and spring data, and the variables were transformed in the same manner as were the spring and summer data. The probability values of tests using Wilk's lambda are summarized in Table 3-36 for white perch and total fish combined. Since the winter data were insufficient to support analysis, only two seasons, summer and spring, were considered.

Table 3-36

Probability Values of Wilk's Lambda Test for All Fish and White Perch

Source	DF	All Fish	White Perch
Season	1	<0.01	<0.01
Area	2	0.69	0.03
Season x Area	2	0.01	0.07
Tide	1	0.19	0.87
Area x Tide	2	0.90	0.92
Season x Area x Tide	2	0.18	0.10

Several hypotheses were rejected at the $\alpha = 0.05$ level of significance for all fish combined and for white perch. The seasonal effect was particularly significant for total fish and white perch. Since only two seasons were involved, the tests for significance of seasonal contrasts were unnecessary.

To determine which of the three response variables were affected by seasonal differences, univariate analyses of variance were computed for all fish combined and for white perch. Probabilities associated with the respective F-tests are given in Table 3-37.

Table 3-37

Probabilities of F Tests by Variable for White Perch and All Fish Combined

	All Fish			White Perch		
Source of Variation	Proportion Infested	*Ergasilus* Density	No. *Ergasilus* per Fish	Proportion Infested	*Ergasilus* Density	No. *Ergasilus* per Fish
Season	<0.01	0.55	<0.01	<0.01	0.55	<0.01
Area	0.51	0.34	0.88	0.30	0.34	0.01
Season x Area	0.07	0.03	0.01	0.18	0.03	0.23
Tide	0.83	0.49	0.05	0.76	0.49	0.81
Area x Tide	0.40	0.91	0.76	0.54	0.91	0.83
Season x Area x Tide	0.56	0.02	0.84	0.39	0.02	0.45

For the seasonal effect, it is obvious that the proportion infested and the number of Ergasilus per infested fish were affected by the seasons, while Ergasilus density was not. The seasonal effects for all fish and white perch were quite similar. This is no doubt due to the predominance of white perch catches in both seasons tested.

From Table 3-37 it is obvious that the significance of the area term in the white perch data greatly affected the number of Ergasilus per infested fish. The mean number of Ergasilus per infested fish is given by area in the following data:

	Affected Area		
	Always	Never	Sometimes
Number of Ergasilus per Infested Fish	3.56	3.89	4.43

These results indicate that overall the number of Ergasilus per infested fish was smallest in the always-affected area (thermal discharge vicinity) and largest in the sometimes-affected area (Saltpeter Creek mouth). However, Ergasilus densities in the water column were not significantly different by seasons or area.

The season-by-area interaction term was significant for white perch and total fish catch (although significant at the $\alpha = 0.07$ level for white perch). From the univariate analyses of variance, it is obvious that the significance of the season-by-area interaction came from the Ergasilus density. A season-by-area interaction plot for Ergasilus density is given in Figure 3-15. This plot reveals that Ergasilus densities were roughly constant at the always-affected area across seasons. However, Ergasilus densities were higher in spring than in summer for the sometimes-affected area, whereas data for the never-affected area displayed precisely the opposite result. These results were identical for white perch and all fish combined.

For all fish combined, the season-by-area interaction was significant for both the proportion of fish infested and the number of Ergasilus per infested fish. The interaction plots are given in figures 3-16 and 3-17 respectively for the proportion infested and the number of Ergasilus per infested fish.

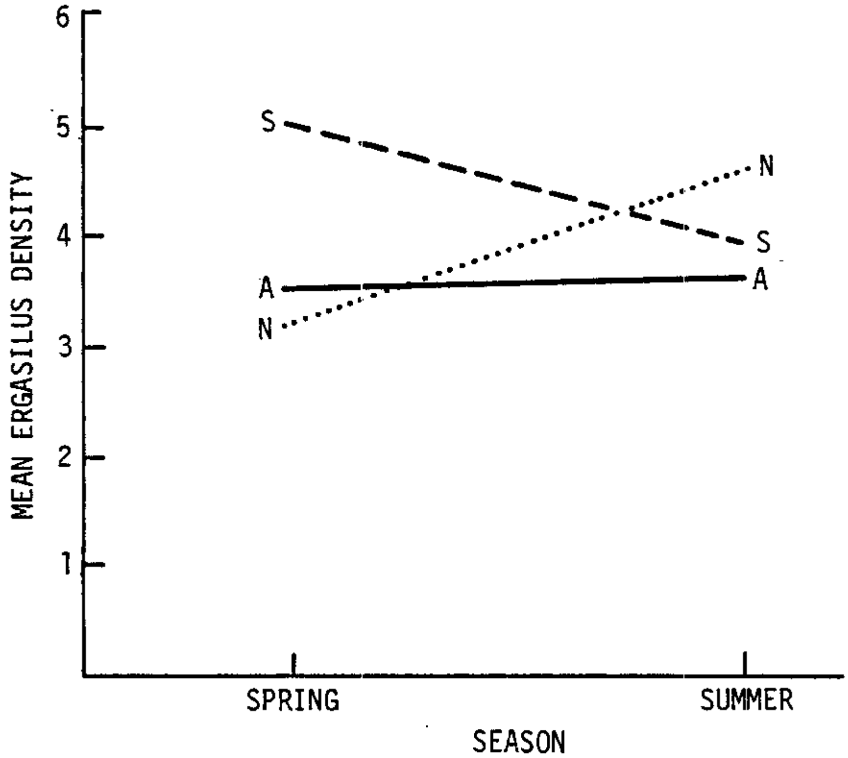

Figure 3-15. Seasons-by-Area Interaction Plot for Ergasilus Density

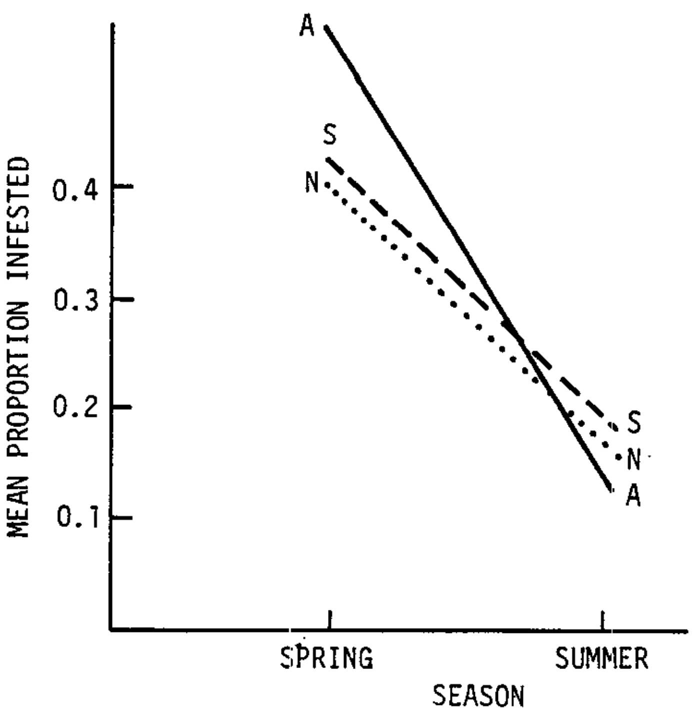

Figure 3-16. Season-by-Area Interaction Plot for Proportion Infested (All Fish)

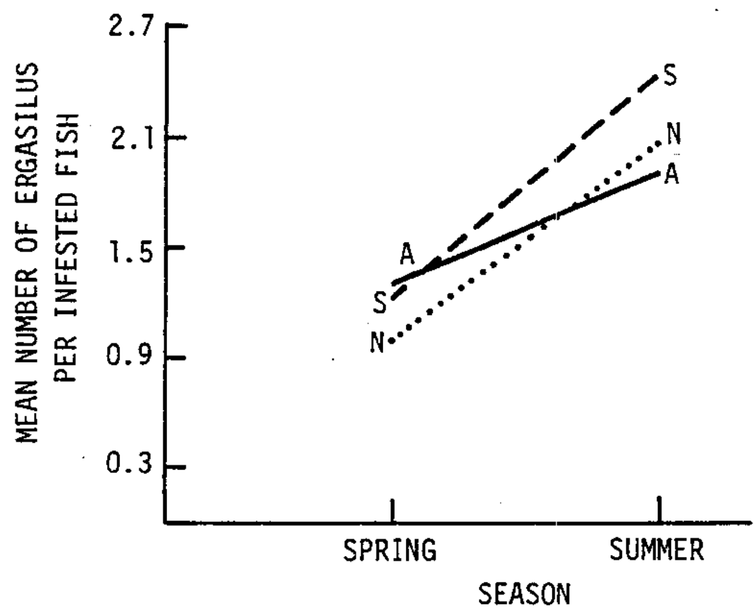

Figure 3-17. Season-by-Area Interaction Plot for Number of Ergasilus per Infested Fish (All Fish)

Results of these tests show that the decrease from spring to summer in the proportion of total fish infested was decidely greater in the always-affected area than the decreases in the other two areas. Also, the increase from spring to summer in the number of Ergasilus per infested fish in the always-affected area was decidely less than the increases in the sometimes-affected and never-affected test areas (Figure 3-17).

Results of parasite analyses over three seasonal test periods can be summarized as follows:

Summer 1979 — Spot was the fish species most frequently and heavily parasitized with Ergasilus spp.; all other target species carried moderate to light Ergasilus parasite loads. Infestations by Argulus alosae were infrequent and light, due possibly to this parasite abandoning its host upon removal from the water. Environmental conditions in the always-affected and never-affected test areas did not seem to influence the proportion of white perch and spot infested, the severity of the infestation, or Ergasilus densities in the water column but did affect the total proportion of fish infested and the number of Ergasilus per infested fish. Overall, a greater proportion of infested and more heavily parasitized fish was collected in the never-affected control area in the Gunpowder River off Battery Point than in the vicinity of the C.P. Crane thermal discharge. This apparent "lessened parasitism effect" observed for catches in the plant discharge vicinity was attributable to the community imbalance created by the apparent thermal exclusion of spot (the most heavily parasitized species) from the discharge area.

Winter (January) 1980 — Neither fish catches nor zooplankton water column densities were sufficient to support statistical analyses. Of the six target species examined, white perch was the most often and most heavily parasitized by Ergasilus spp. Severity of infestion was highest in the vicinity of the thermal discharge and lowest at Saltpeter Creek mouth; however, the low number of fish examined render this finding somewhat tenuous. Yellow perch were lightly parasitized, displaying single occurrences of infestations in the discharge area and off Battery Point. All other target species examined carried light parasite (Ergasilus spp.) loads.

Spring 1980 — Of the six target species examined during spring 1980, white perch was the most frequently and most heavily parasitized by Ergasilus spp. Other target species (pumpkinseed, yellow perch, channel catfish, and carp) displayed low infestation levels in all test areas. Environmental conditions (e.g. temperature) in the always-affected area and sometimes-affected area seemed to influence Ergasilus water column densities and the number of Ergasilus per infested fish but not the proportion of infested fish for white perch or all fish combined. Numbers of Ergasilus per infested fish in the never-affected area off Battery Point were significantly smaller than the severities observed for fish taken in the sometimes- and always-affected areas. Ergasilus densities in the sometimes-affected area (Saltpeter Creek mouth) were significantly higher than densities in the always- and never-affected test areas. Therefore, although the proportion of total fish (predominantly white perch) infested by Ergasilus spp. was not significantly different for any station. Environmental conditions (e.g. water temperature) in the vicinity of the thermal discharge and sometimes-affected Saltpeter Creek mouth may have caused increased severity of parasitic infestation in these two test areas. Infestations by Argulus alosae were infrequent and light.

Seasons Combined — Based on summer and spring data combined for white perch and total fish catch (dominated by white perch), the number of Ergasilus spp. per infested fish (severity) was smallest in the always- affected area (thermal discharge vicinity) and largest in the sometimes-affected area of Saltpeter Creek mouth. However, Ergasilus water column densities were not significantly different for any season or test area. For all fish combined, the decrease from spring to summer in the proportion of total fish infested was decidedly greater in the always-affected area than the decreases observed in the other two test areas. Further, the increase from spring to summer in the number of Ergasilus per infested fish (severity of infestation) in the vicinity of the thermal discharge was decidedly less than the increases observed at Saltpeter Creek mouth or the area off Battery Point. Both of these latter effects are attributed to the community imbalance created by the apparent thermal exclusion of spot (the most heavily parasitized species during the summer season) from the always-affected area (C.P. Crane thermal discharge) during the summer 1979 sampling period.

C. TARGET SPECIES

Because of their abundance in the C.P. Crane study area and importance to the system's fish community integrity, several species — spot, white perch, yellow perch, pumpkinseed, channel catfish, and mummichog — were chosen as target or key indicator species for detailed study of their spatial distribution, length composition, overt parasite/abnormalities load, condition and length-weight analyses. The following subsections deal with these species' spatial distribution, overt parasite/abnormalities load, and length composition during the 1979-1980 study period.

1. Spot

The spot (Leiostomus xanthurus) accounted for 74.7 percent (7,288 individuals) and 2.2 percent (54 individuals) of the trawl and seine catch respectively during the 1979 summer period. Higher catches occurred on low tide rather than high tide for both gear types (tables 3-1 and 3-2).

Statistical analyses indicated that significantly ($\alpha = 0.05$) fewer spot (925 specimens) were collected by trawl at Saltpeter Creek thermal discharge than at Saltpeter Creek mouth (3,378 specimens) or at Battery Point in the Gunpowder River (2,985 specimens), suggesting possible thermal exclusion from this area (see subsection III.A). No significant differences in spatial distribution were observed for seine catches. The great majority of spot collected by trawl and seine were in the 70- to 90-mm length range. The mean length of spot collected by trawl in the discharge area was somewhat smaller ($\bar{x} = 79.9$ mm) than the mean length of specimens taken at Saltpeter Creek mouth (87.3 mm) or at Battery Point (88.2 mm). Spot were not collected in the C.P. Crane study area during the winter or spring sampling periods.

Spot was the most often and most heavily parasitized species, displaying almost 100 percent Ergasilus infestation occurrence in all three test areas. Statistical analyses revealed no statistically significant differences in the frequency or severity of infestation among stations. No obvious evidence of abnormalities or malformations were observed; a single specimen captured off Battery Point was observed to have an ulceration (sore) in the vicinity of the anal fin (Table 3-38).

A total of 1,752 spot taken from summer 1979 trawl samples were analyzed for length-weight and condition factor (K) differences among thermally affected and unaffected areas. This large sample size ($n = 1,752$) resulted in Levene's test being significant; however, the within-group variances were virtually identical. Further testing revealed no significant difference among b (slope) values at the three test areas, but a (y intercept) values were judged to be different (tables 3-39 and 3-40). Despite differences observed for a values, the finding of no significant differences in the slopes of regression lines among the three test areas indicates that there were no significant differences in the overall length-weight relationships for spot taken by trawl at thermally affected and unaffected areas during the summer 1979 season.

Mean condition ($\bar{K}$) of spot collected by trawl in the thermal discharge vicinity was lower ($\bar{K} = 1.09$) than for spot taken at Saltpeter Creek mouth ($\bar{K} = 1.15$) and Battery Point ($\bar{K} = 1.16$) (Table 3-41). This

Table 3-38

Overt Parasitism/Disease and Malformations Observed for Key Finfish Collected by Trawl and Seine in Vicinity of C.P. Crane Generating Station, 1979-1980

Season	Species	Station	Parasite/Disease	No. Affected	Location
Summer (July-August 1979)	White perch	03	Ulceration	12	Anal fin
		03	Ulceration	1	Pelvic fin
		05	Ulceration	1	Pelvic and anal fins
		05	Ulceration	2	Anal fin
	Spot	05	Ulceration	1	Anal fin
	Channel catfish	05	Ulceration	1	Anal fin
Winter (January 1980)	White perch	03	Hirudinea (leeches)	8	Fins and body surface
	Pumpkinseed	03	Hirudinea	3	Fins
		05	Hirudinea	4	Fins
	Yellow perch	05	Hirudinea	1	Fins
Spring (April-May 1980)	White perch	03	Hirudinea	2	Fins and body surface
		03	Achtheres sp. (copepod)	3	Gill arch
		03	Piscicolidae (leeches)	3	Fins and body surface
		04	Hirudinea	7	Fins and body surface
		04	Achtheres sp.	8	Gill arch
		04	Piscicolidae	1	Fins
		04	Lernea sp. (anchor worm)	1	Body surface
		05	Hirudinea	3	Fins and body surface
		05	Achtheres sp.	5	Gill arch
		05	Piscicolidae	3	Fins and body surface
		05	Ulceration	2	Body surface
	Yellow perch	04	Hirudinea	2	Fins and body surface
		05	Piscicolidae	1	Fins
	Pumpkinseed	03	Hirudinea	2	Fins and body surface
		03	Piscicolidae	1	Fins
		04	Achtheres sp.	1	Gill arch
		04	Piscicolidae	4	Body surface
	Carp	05	Ulceration	1	Body surface
		05	Tumor	1	Gill arch

Table 3-39

Analysis of Variance for Regression Lines for Length-Weight Analysis of Spot Collected by Trawl in Vicinity of C.P. Crane Generating Station, Summer 1979

SOURCE OF VARIATION	D.F.	SUMS OF SQUARES	MEAN SQUARE	F RATIO	PR > F
COMMON LINE	4	.16786331413	.41965828532D-01	10.47625	0.0000
COMMON SLOPE	2	.11142703512D-02	.55713517560D-03	.1390818	0.8702
SLOPE OF GROUP MEANS VERSUS AVERAGE WITHIN GROUP SLOPE	1	.16668095328	.16668095328	41.60982	0.0000
GROUP MEANS ABOUT THEIR REGRESSION LINE	1	.68090495920D-04	.68090495920D-04	.1699794D-01	0.8963
ERROR	1746	6.9941407209	.40058079730D-02		
COMMON INTERCEPT (ASSUMES A COMMON SLOPE)	2	.16674904378	.83374521889D-01	20.83393	0.00000
ERROR	1748	6.9952549912	.40018621231D-02		
REGRESSION ABOUT THE OVERALL LINE	1	45.305152626	45.305152626	11070.09	0.0000
RESIDUAL ABOUT THE OVERALL LINE	1750	7.1620040350	.40925737343D-02		
TOTAL	1751	52.467156661			

REFERENCES: BROWNLEE, K.A. (1965) 'STATISTICAL THEORY AND METHODOLOGY' JOHN WILEY AND SONS, NEW YORY PP. 376-388.

JOHNSON, N.L. AND LEONE, F.C. (1968) 'STATISTICS AND EXPERIMENTAL DESIGN' VOLUME II, JOHN WILEY AND SONS, NEW YORK PP. 84-88.

Table 3-40

Analysis of Pooled Data for Length-Weight Analysis of Spot Collected by Trawl in Vicinity of C.P. Crane Generating Station, Summer 1979

GROUP	A	S.E. A	95 PERCENT C.I. A	B	S.E. B	95 PERCENT C.I. B	SAMPLE SIZE	ERROR MEAN SQUARE
1	-5.072822	.1829594	-5.431422 -4.714221	3.055556	.9621174D-01	2.866981 3.244131	405	.5340156D-02
2	-5.095249	.1027518	-5.296642 -4.893855	3.079056	.5298295D-01	2.975209 3.182903	626	.3668958D-02
3	-5.022056	.7643058D-01	-5.171860 -4.872252	3.042471	.3934721D-01	2.965351 3.119592	721	.3550248D-02
MEAN	-5.054447	.5982717D-01	-5.171708 -4.937186	3.055726	.7398516D-03	3.054276 3.057176	1752	.4005808D-02

NOTE THAT THE ABOVE M.S. ERROR FOR THE POOLED LINE IS DERIVED FROM THE POOLED WITHIN LINE ERROR.

LEVENE'S TEST STATISTIC FOR THE EQUALITY OF THE GROUP VARIANCES IS

F(2, 1749) = 12.9768

PROBABILITY OF A LARGER F VALUE IS
P = 0.0000

REFERENCES: BROWN, M.B. AND FORSYTHE, A.B. (1974) ROBUST TESTS FOR THE EQUALITY OF VARIANCES, 'JOURNAL OF THE AMERICAN STATISIICAL ASSOCIATION',69 PP. 364-367.

DRAPER, N.R. AND AUNTER, W.G. (1969) TRANSFORMATIONS: SOME EXAMPLES REVISITED, 'TECHNOMETRICS', 11 PP. 23-40.

THE FOLLOWING ANALYSIS OF VARIANCE ASSUMES THE GROUP VARIANCES ARE EQUAL.

Table 3-41

Mean Condition Factor, $\bar{K}$, for Spot Collected in the C.P. Crane Study Area, Summer 1979

GEAR=12 FT SEMIBALLOON OTTER TRAWL SPECIES=SPOT

RANGEMIN	RANGEMAX	X3_K	X3_FREQ	X4_K	X4_FREQ	X5_K	X5_FREQ
51	60	.	.	.	.	1.20	1.00
61	70	1.17	13.00	1.00	11.00	1.17	17.00
71	80	1.10	250.00	1.17	123.00	1.16	190.00
81	90	1.07	122.00	1.15	336.00	1.15	286.00
91	100	1.15	11.00	1.16	115.00	1.16	113.00
101	110	1.23	6.00	1.13	26.00	1.18	78.00
111	120	1.14	2.00	1.16	5.00	1.15	20.00
121	130	.	.	1.17	3.00	1.18	5.00
131	140	1.08	1.00	1.19	5.00	1.21	2.00
141	150	.	.	1.21	2.00	1.18	1.00
AVERAGE		1.09	79.98	1.15	87.36	1.16	88.19
# MEASURED		405.00	405.00	626.00	626.00	721.00	721.00

GEAR=BEACH SEINES SPECIES=SPOT

RANGEMIN	RANGEMAX	X3_K	X3_FREQ	X4_K	X4_FREQ	X5_K	X5_FREQ
61	70	.	.	.	.	1.27	2.00
71	80	1.17	2.00	.	.	1.18	2.00
81	90	1.17	6.00	.	.	1.05	10.00
91	100	1.17	10.00	1.10	1.00	1.07	6.00
101	110	1.14	2.00	1.00	3.00	1.00	3.00
111	120	.	.	1.00	1.00	1.18	1.00
121	130	.	.	1.02	1.00	.	.
131	140	.	.	1.23	2.00	1.13	1.00
AVERAGE		1.17	91.60	1.07	115.25	1.08	92.16
# MEASURED		20.00	20.00	8.00	8.00	25.00	25.00

Station Location Legend

X3=Saltpeter Creek (Thermal Discharge)
X4=Saltpeter Creek (Mouth)
X5=Gunpowder River (Battery Point)

difference in $\overline{K}$ as well as a value (y intercept) can be attributed to the somewhat shorter mean length of spot collected in the thermal discharge vicinity ($\bar{x}$ = 79.7 mm) versus the mean length of spot taken at Saltpeter Creek mouth ($\bar{x}$ = 87.3 mm) or at Battery Point ($\bar{x}$ = 88.2 mm) (Table 3-42).

For the 53 spot analyzed from seine samples, results were similar to those observed for trawl catches, i.e. no significant differences in b (slope) values among areas and slightly significant diferences in a (y intercept) values ($\alpha = 0.10$) (tables 3-43 and 3-44). Mean condition factor for seine-caught spot was highest at thermal discharge station 03, due primarily to the greater relative proportion of slightly larger fish (91-100 mm) collected at this station (tables 3-41 and 3-45).

2. White Perch

White perch (Morone americana) contributed 15.3 percent (1,487 specimens) and 8.1 percent (202 individuals) to trawl and seine catches respectively in the C.P. Crane site area during summer 1979. Overall, more white perch were collected on high tide than on low tide (tables 3-1 and 3-2). Statistical analyses revealed no significant differences in the trawl catches at Saltpeter Creek mouth (64 individuals) and Battery Point (101 individuals) but significantly ($\alpha = 0.05$) higher catches (1,322 specimens) at Saltpeter Creek thermal discharge, suggesting thermal attraction to this area (see subsection 3.A). White perch seine catches were significantly ($\alpha = 0.05$) larger at Battery Point (111 specimens) than at Saltpeter Creek mouth (21 specimens) or Saltpeter Creek discharge (70 specimens). However, the magnitude of these differences based on such small catches does not seem to indicate a true avoidance/preference condition as seen for trawls.

Only 18 white perch were collected by trawl during the winter season, contributing 5.9 percent to the total catch. Twice as many individuals were collected on low tide as on high tide, but the low numbers encountered render this finding of little importance. No white perch were collected in seine in the C.P. Crane study area during winter.

Table 3-42

Length Frequency Distribution (Extrapolated to Total Catch) of Target Fish Species Collected by Trawl at Three Experimental Stations in the Vicinity of C.P. Crane Generating Station, July-August 1979

SPECIES=WHITE PERCH

RANGEMIN	RANGEMAX	X3	X4	X5
0	10	2.0	.	.
20	30	5.0	5.0	11.0
30	40	27.0	9.0	9.0
40	50	29.0	37.0	7.0
50	60	9.0	3.0	.
60	70	7.0	2.0	.
80	90	56.0	.	.
90	100	405.0	.	6.0
100	110	351.0	3.0	22.0
110	120	151.0	2.0	9.0
120	130	43.0	.	5.0
130	140	47.0	.	5.0
140	150	59.0	1.0	4.0
150	160	32.0	.	9.0
160	170	40.0	1.0	9.0
170	180	22.0	1.0	2.0
180	190	22.0	.	2.0
190	200	9.0	.	1.0
200	210	5.0	.	.
260	270	2.0	.	.
# MEASURED		735.0	64.0	82.0
MEAN LENGTH		109.3	54.6	105.0
SE		1.1	3.9	5.4
TOTAL CATCH		1322.0	64.0	101.0

SPECIES=SPOT

RANGEMIN	RANGEMAX	X3	X4	X5
40	50	2.0	.	.
50	60	.	.	4.0
60	70	30.0	59.0	70.0
70	80	570.0	668.0	786.0
80	90	278.0	1810.0	1182.0
90	100	25.0	620.0	467.0
100	110	14.0	140.0	327.0
110	120	5.0	27.0	116.0
120	130	.	16.0	21.0
130	140	2.0	27.0	8.0
140	150	.	11.0	4.0
# MEASURED		406.0	627.0	722.0
MEAN LENGTH		79.9	87.3	88.2
SE		0.4	0.4	0.4
TOTAL CATCH		925.0	3378.0	2985.0

SPECIES=YELLOW PERCH

RANGEMIN	RANGEMAX	X3	X4	X5
50	60	1.0	.	.
60	70	1.0	.	1.0
120	130	1.0	1.0	.
130	140	.	1.0	.
140	150	1.0	.	.
# MEASURED		4.0	2.0	1.0
MEAN LENGTH		98.5	128.0	68.0
SE		21.5	3.0	.
TOTAL CATCH		4.0	2.0	1.0

SPECIES=CHANNEL CAT

RANGEMIN	RANGEMAX	X3	X4	X5
30	40	.	.	3.0
40	50	.	2.0	.
50	60	.	3.0	.
70	80	2.0	.	.
80	90	2.0	.	.
90	100	.	2.0	.
140	150	2.0	.	.
160	170	2.0	.	10.0
170	180	4.0	.	10.0
180	190	.	5.0	5.0
260	270	.	.	3.0
# MEASURED		6.0	7.0	12.0
MEAN LENGTH		136.0	116.4	169.8
SE		18.3	24.3	14.5
TOTAL CATCH		12.0	12.0	31.0

SPECIES=PUMPKINSEED

RANGEMIN	RANGEMAX	X3	X4	X5
35	40	1.0	.	.
105	110	.	.	1.0
125	130	1.0	.	.
# MEASURED		2.0	.	1.0
MEAN LENGTH		83.0	.	110.0
SE		43.0	.	.
TOTAL CATCH		2.0	0.0	1.0

STATION LOCATION LEGEND

X3 = SALTPETER CREEK (THERMAL DISCHARGE)
X4 = SALTPETER CREEK (MOUTH)
X5 = GUNPOWDER RIVER (BATTERY POINT)

Table 3-43

Analysis of Variance for Regression Lines for Length-Weight
Analysis of Spot Collected by Seine in Vicinity of C.P. Crane Generating Station, 1979-1980

SOURCE OF VARIATION	D.F.	SUMS OF SQUARES	MEAN SQUARE	F RATIO	PR > F
COMMON LINE	4	.21359455278D-01	.53398638195D-02	1.814325	0.1420
COMMON SLOPE	2	.69245111711D-02	.34622555855D-02	1.176370	0.3173
SLOPE OF GROUP MEANS VERSUS AVERAGE WITHIN GROUP SLOPE	1	.20065376427D-03	.20065376427D-03	.6817611D-01	0.7952
GROUP MEANS ABOUT THEIR REGRESSION LINE	1	.14234290343D-01	.14234290343D-01	4.836384	0.0328
ERROR	47	.13832890613	.29431682155D-02		
COMMON INTERCEPT (ASSUMES A COMMON SLOPE)	2	.14434944107D-01	.72174720535D-02	2.434753	0.09815
ERROR	49	.14525341730	.29643554551D-02		
REGRESSION ABOUT THE OVERALL LINE	1	1.7214815113	1.7214815113	549.7931	0.0000
RESIDUAL ABOUT THE OVERALL LINE	51	.15968836141	.31311443413D-02		
TOTAL	52	1.8811698727			

REFERENCES: BROWNLEE, K.A. (1965) 'STATISTICAL THEORY AND METHODOLOGY' JOHN WILEY AND SONS, NEW YORY PP. 376-388.

JOHNSON, N.L. AND LEONE, F.C. (1968) 'STATISTICS AND EXPERIMENTAL DESIGN' VOLUME II, JOHN WILEY AND SONS, NEW YORK PP. 84-88.